The Engineer

OCTOBER 2, 1953 28, ESSEX ST., STRAND, LONDON, W.C.2. TWO SHILLINGS

UNIVERSITY OF MICHIGAN
OCT 16 1953
ENGINEERING LIBRARY

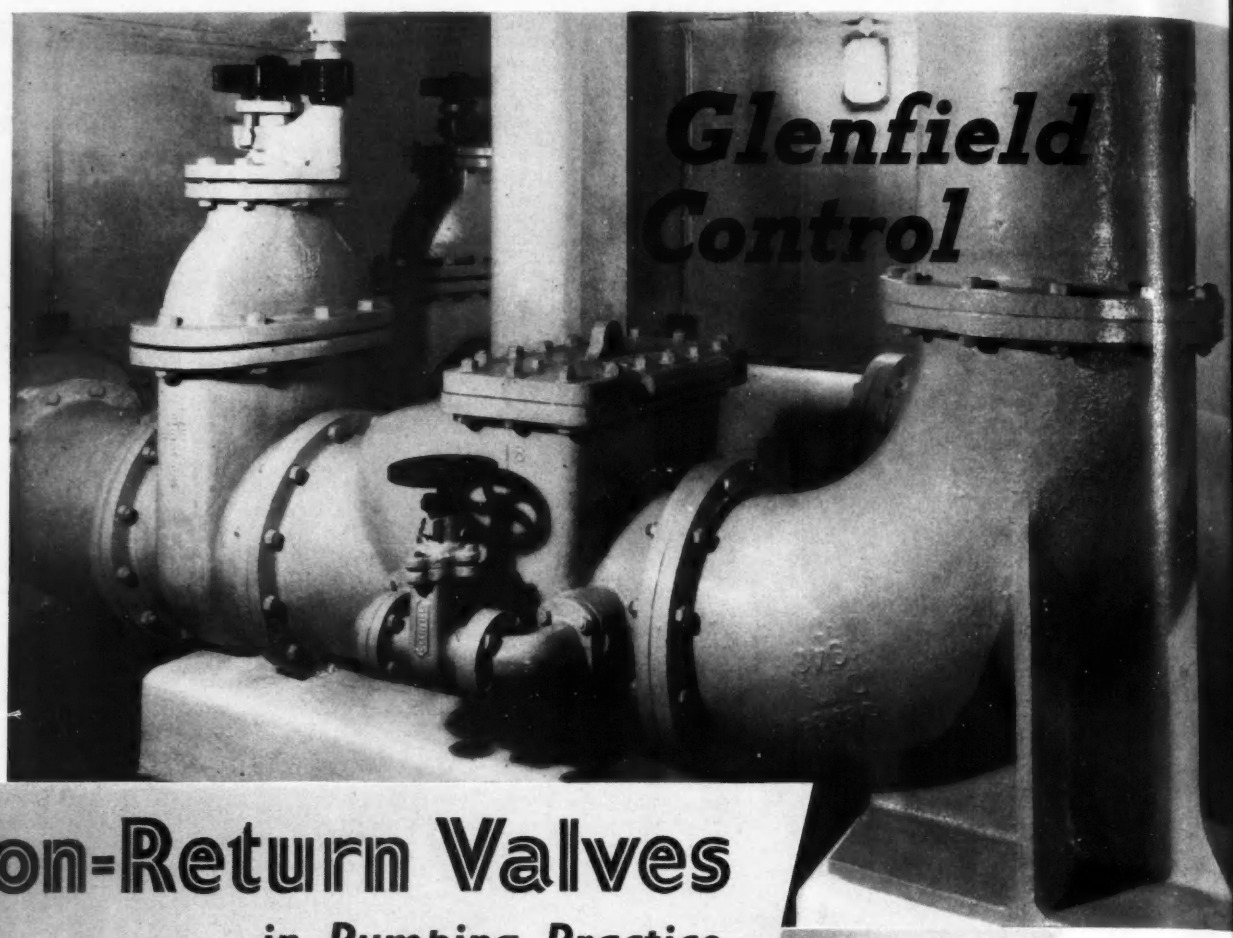
"Corronel B" is the latest addition to the Wiggin range of high-nickel alloys. A nickel-molybdenum-iron alloy, it is of particular interest because of its exceptional resistance to most acids (but especially hydrochloric acid in any strength and at any temperature—including boiling). It has already been tested and proved in service and is now available in this country in wrought form.

A publication giving detailed properties of CORRONEL B is available free of charge.*
**Trade Mark.*

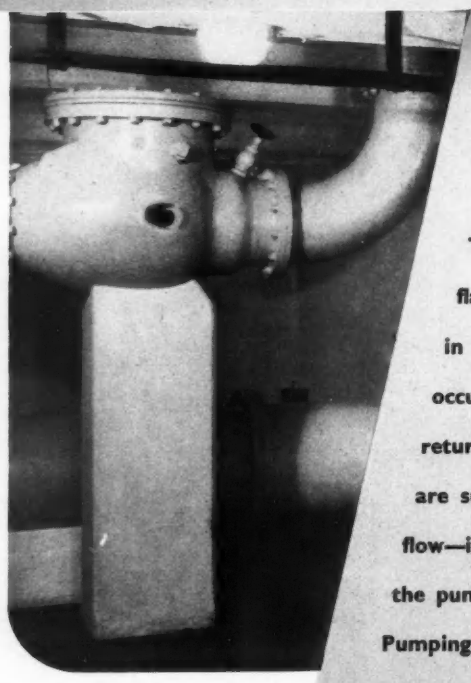
HENRY WIGGIN

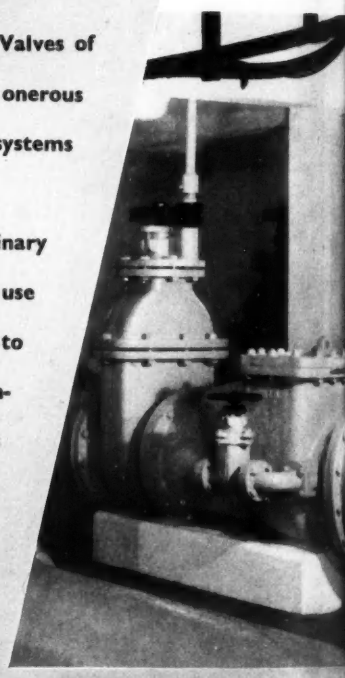
HENRY WIGGIN & COMPANY LTD., WIGGIN STREET, BIRMINGHAM, 16

3s/CR/1014



Non-Return Valves
in Pumping Practice





Innumerable Glenfield Non-Return Valves of various types are performing the onerous duty of "reflux control" in pumping systems in all parts of the World.

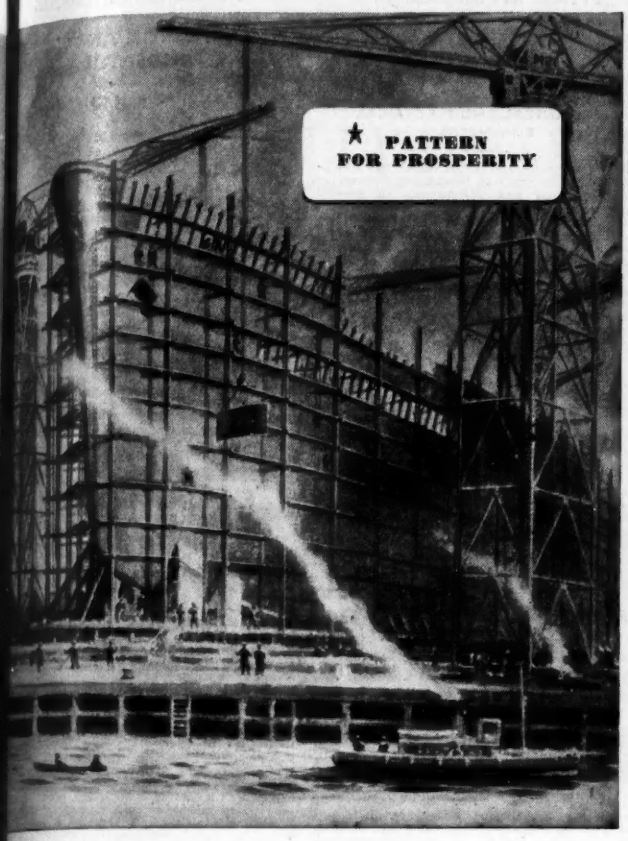
The photographs show an 18 in. dia. ordinary flap type of non-return valve—for general use in systems where rapid reflux is unlikely to occur—and a 12 in. dia. "Recoil" type non-return valve—for use where water columns are subject to abnormally rapid reversal of flow—installed, with other Glenfield valves, in the pump house basement of Fighting Cocks Pumping Station, Tees Valley Water Board.

Photographs by courtesy of T. S. R. Winter, Esq., M.I.C.E., A.M.I.W.E., Engineer & General Manager, Tees Valley Water Board.

Glenfield

GLENFIELD & KENNEDY LIMITED KILMARNOCK

Head Office and Works: KILMARNOCK, SCOTLAND



★

More than half the World's total of new shipping is now being built in British yards and the industry is on the threshold of a prosperity unknown in the peaceful years. This is the reward of technical progress and high productivity, for the industry has been quick to see the need for adapting yards to newer methods of construction, large-scale prefabrication, and the employment of modern metal-working techniques. This is why Wimet carbide tools are being increasingly used for a multitude of metal-working applications in this great industry.

Wimet

WICKMAN *of* COVENTRY

270 ST

THE ENGINEER

ESTABLISHED 1856

Vol. 196 No. 5097

OCTOBER 2, 1953

28, Essex Street, Strand, London, W.C.2

Telephone : CENtral 6565 Telegrams : Engineer Newspaper, Estrand, London

Published every Friday Registered as a Newspaper

PRINCIPAL CONTENTS

(Complete contents on page 432)

Railway Motive Power Transition 432

A Short History of Spectroscopy—No. IX ... 418
(T. W. CHALMERS)

Institution of Naval Architects—No. II 422

The Third European Machine Tool Exhibition —No. III 419

An Aluminium Alloy Bascule Bridge 429

A Large Boring Mill 435

Performance and Efficiency Tests on S.R. Diesel Electric Locomotives—No. I 424
(O. S. NOCK)

The British Electricity Authority 434

NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

U.K. & ABROAD £5. 10. 0. CANADA £5. 5. 0. annually including postage. Every subscriber is entitled to one FREE copy of the BUYERS GUIDE as published —extra copies 5s. each post free.

CLASSIFIED ADVERTISEMENTS

LINEAGE RATE (Under 1 inch):—2s. 6d. per line of 6 words. Minimum 10s.

INCH RATE (1 inch and over):—Rates per insertion per single column inch— 1 insertion—30s. 6 insertions—27s. 6d. 13 insertions—26s. 26 insertions—25s.

USE OF BOX NUMBER: The charge is 2s. including the cost of re-addressing replies, which are forwarded immediately on receipt. N.B. There is no Charge for Box Nos. under "Situations Wanted."

WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

INDEX TO ADVERTISERS—PAGE 119

PUBLIC APPOINTMENTS

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURER

Applications are invited for the post of LECTURER in the Department of Mechanical Engineering. The initial salary will be within the range £550–£1100 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than 17th October, 1953, by the undersigned, from whom further particulars of the conditions of appointment may be obtained.

STANLEY DUMBELL,
Registrar.

September, 1953. E5522

PETERBOROUGH JOINT EDUCATION BOARD

PETERBOROUGH TECHNICAL COLLEGE

ASSISTANT TEACHER (GRADE B)

Applications are invited for the post of full-time ASSISTANT TEACHER (Grade B) in the Engineering Department. The successful candidate must be able to teach production engineering subjects up to Higher National Certificate level and should have had industrial experience. Some teaching experience is desirable, though not essential. Salary (which includes allowances for training and qualifications and also increments for teaching and/or industrial experience) will be in accordance with the conditions of the Burnham Technical Scale.

Further particulars and application form will be sent by the undersigned on receipt of a stamped, addressed foolscap envelope. Application should be made within fourteen days of the appearance of this advertisement.

LESLIE TAIT,
Chief Education Officer.

Education Offices,
Town Hall,
Peterborough. E5487

NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

PRINCIPAL

Applications are invited for the post of PRINCIPAL in succession to Mr. W. H. Thorp, M.A., on his retirement early in 1954. The College, a tripartite organisation with branches at Zaria, Ibadan and Enugu, is independent, residential, and being developed along the lines of a major Technical College in the U.K. Its work is largely post-school certificate and includes teacher training.

Qualifications: good Hon. Degree and teaching experience in science, engineering or arts, professional qualifications, if appropriate, and experience of administration with high degree of responsibility.

The post is permanent and pensionable. Salary £2570 p.a., including overseas pay. Furnished house provided at rent £150 p.a. Free first-class passages once each way for each tour of service (normally 10–15 months) for person appointed and wife; either a passage allowance or a maintenance allowance for up to two children under 18. Income tax at local rates. Leave on full salary at rate of seven days for each completed month of resident service.

Write for further information to Secretary, Advisory Committee on Colonial Colleges, 1, Gordon Square, W.C.1. Closing date for applications 31st October, 1953. E5499

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

LECTURER IN ELECTRICAL ENGINEERING

The Governing Body invites applications for a post as LECTURER in ELECTRICAL ENGINEERING. Duties will commence as soon as possible.

Candidates should hold a Degree in Electrical Engineering and should be able to teach up to Final Degree standard. Salary in accordance with the Burnham Technical Scale for Lecturers (£940 by £25 to £1040).

Further particulars and application form will be sent by the undersigned on receipt of a stamped, addressed foolscap envelope. Last date for receipt of applications Wednesday, 14th October, 1953. Applications not on the form provided will be disregarded.

E. C. SMITH,
Principal.

22nd September, 1953. E5502

WEST RIDING COUNTY COUNCIL

BARNOLDSWICK TECHNICAL INSTITUTE

ASSISTANT GRADE "B"

ASSISTANT, Grade "B," required to teach engineering subjects in City and Guilds and Ordinary National Certificate in Mechanical Engineering Courses. Candidates should be suitably qualified and have had good industrial experience. Salary £490 by £25 to £765, with increments for graduate qualifications, approved training and industrial experience.

Application forms should be returned within 14 days of the appearance of this advertisement to H. Marsden, Divisional Education Officer, High Street House, Skipton. E5540

PUBLIC APPOINTMENTS

SURREY EDUCATION COMMITTEE

BROOKLANDS COUNTY TECHNICAL COLLEGE, HEATH ROAD, WEYBRIDGE

ASSISTANTS

Applications are invited for the following posts:—

(1) Full-time Grade B ASSISTANT in ELECTRICAL ENGINEERING.

Applicants should possess a Degree in Electrical Engineering of a British University or its equivalent and have had adequate industrial and teaching experience. Corporate Membership of the Institution of Electrical Engineers will be an added recommendation.

The successful candidate will be required to teach to the Ordinary National Certificate standard at present besides subjects pertaining to allied trades.

(2) Full-time Grade B ASSISTANT in MECHANICAL ENGINEERING.

Applicants should be Graduates of a British University and/or Corporate Members of the Institution of Mechanical Engineers and have had adequate industrial and teaching experience. Candidates will be required to teach up to the Ordinary and Higher National Certificate standard. Preference will be given to candidates who can offer the subjects of strength of materials, theory of machines and mechanics of fluids at the higher standard.

(3) Full-time Grade A ASSISTANT in PRODUCTION ENGINEERING.

The work will at present be concerned with Ordinary National Certificate Courses in Production Engineering and the City and Guilds of London Institute Trades Courses requirements in allied subjects. Applicants should possess sound technological qualifications, good industrial and teaching experience. Preference will be given to those with a knowledge of machine tools, jigs and fixtures, metrology, heat treatment and welding practice.

Salaries (for men): Grade B £490 by £25 to £765 p.a.; Grade A £415 by £18 to £670 p.a.

Applicants with suitable teaching or industrial experience may be appointed above the minimum of the scale.

Duties for all posts will be divided between day and evening classes.

Forms of application for the posts may be obtained from the Registrar, Brooklands County Technical College, Heath Road, Weybridge, to whom they should be returned within 2 weeks of the appearance of this advertisement. E5525

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

HEAD OF DEPARTMENT

The Governing Body invites applications for the post of HEAD OF THE DEPARTMENT of Civil Engineering and Building. Duties will commence as soon as possible.

Candidates should hold a Degree in Civil Engineering or A.R.I.B.A. Approved experience in the building industry would be an additional recommendation. A commencing salary of up to £1040 may be paid to a suitably qualified candidate.

Further particulars and application form will be sent by the undersigned on receipt of a stamped, addressed, foolscap envelope. Last date for receipt of applications, Thursday, 15th October, 1953. Applications not on the form provided will be disregarded.

E. C. SMITH,
Principal.

25th September, 1953. E5537

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL COLLEGE

LECTURER IN AIRCRAFT STRUCTURES

Farnborough, Hants, Royal Aircraft Establishment Technical College (selective) requires LECTURER in AIRCRAFT STRUCTURES, to teach subject to Final B.Sc. and H.N.C. standard. Facilities for research may be available. Qualifications: Degree or equivalent with considerable teaching and industrial or research experience. Salary on scale £900 by £25 to £1000, plus £40 special addition and subject to Teachers' Superannuation Acts.—Details and forms from Principal, to whom completed forms must be returned within fourteen days of this notice. E5490

BEDFORDSHIRE EDUCATION COMMITTEE

ENGINEERING DEPARTMENT

FULL-TIME LABORATORY TECHNICIAN

Full-time LABORATORY TECHNICIAN (Engineering Department) required at North Bedfordshire College, Bedford. National Certificate or equivalent standard essential. Starting salary within the range £330 to £525, according to qualifications and experience.

Apply immediately for further particulars to the Director of Education, Shire Hall, Bedford. E5412

WESTMINSTER CITY COUNCIL

CITY ENGINEER AND SURVEYOR

Westminster City Council invites applications from gentlemen with appropriate professional or academic qualifications for the appointment of CITY ENGINEER AND SURVEYOR. Age limit 50 years. Salary, £2700 by £100 to £3000 per annum. J.N.C. conditions of service. Further particulars from Town Clerk, Westminster City Hall, Charing Cross Road, London, W.C.2, to whom applications should be sent before 2nd November, 1953. E5516

PUBLIC APPOINTMENTS

AIR MINISTRY

WORKS DEPARTMENT

MECHANICAL AND ELECTRICAL ENGINEERS

Air Ministry require MECHANICAL and ELECTRICAL ENGINEERS in Works Department for design, operation and maintenance of ground mechanical and electrical works services on R.A.F. stations at home and overseas and civil aviation stations. Appointments in two grades: (a) Main Grade, starting salary, £970, rising by eight annual increments to £1280 per annum; (b) Assistant Grade, starting salary, age point, viz., age 25, £628 per annum, rising to £875 at age 34, thereafter rising annually to £970 per annum. Salaries somewhat lower in provinces. Appointments temporary and non-pensionable but with long-term possibilities. Special allowance up to £1300 a year according to location payable in addition to salary during overseas service. Candidates must be natural-born British subjects. Minimum qualifications and experience for both grades of posts: (i) (a) University Degree or equivalent Diploma in Electrical and/or Mechanical Engineering and at least a two-year apprenticeship or (b) Graduate or Corporate Membership of the Institutions of Mechanical or Electrical Engineers with appreciable electrical engineering experience and at least a three-year apprenticeship, and (ii) employment in responsible position for minimum of three years with well-established engineering concern providing wide experience in electrical and mechanical engineering practice.

Application forms, quoting Reference D290/52A, from M.L. and N.S., Technical and Scientific Register (K), Almack House, 26, King Street, London, S.W.1. E5394

ROYAL MIDLAND COUNTIES HOME

LEAMINGTON SPA

ASSISTANT ENGINEER

ASSISTANT ENGINEER required, to take charge of the engineering services at the above Hospital of 126 beds. Whitley Council salary scales and conditions of service (£425 per annum by £15 to £500 per annum). Person appointed will be responsible to the Group Engineer for the maintenance of the engineering equipment and building fabric. Applicants should hold one of the approved qualifications, have served a recognised engineering apprenticeship and have had sound experience in the maintenance and operation of steam boiler, plant, electrical equipment, heating hot water supplies, &c. House available in which the successful applicant will be required to live and for which a rent will be charged. The post is superannuable and the successful candidate will be required to undergo a medical examination. Applications, with the names of three referees, should be sent to the undersigned by the 21st October, 1953.

W. A. JAMES,
Group Secretary.

87, Radford Road,
Leamington Spa. E5489

SURREY COUNTY COUNCIL, COUNTY WELFARE DEPARTMENT, KINGSMEAD, 2, GROVE ROAD, RICHMOND

APPOINTMENT OF ENGINEER

Applications are invited from qualified engineers for the appointment of ENGINEER at Kingsmead, Richmond. This establishment, which is under the control of the County Welfare Committee, provides accommodation for 254 non-sick and 91 sick residents, and the person appointed will be responsible for the efficient maintenance of the mechanical and electrical services operating at the establishment and for the supervision of the work of subordinate staff.

Applicants should have a sound practical experience of all aspects of institutional or hospital engineering and be qualified in accordance with the recommendations of the Professional and Technical Council of the Whitley Councils for the Health Services (Great Britain). The salary scale applicable to qualified applicants is £500 by annual increments of £20 to a maximum of £600 per annum.

The appointment is subject to the provisions of the Local Government Superannuation Acts, 1937 to 1953, to the passing of a medical examination and to one month's notice on either side.

Applications, stating age and giving details of present post and past experience, qualifications, &c., together with the names and addresses of two referees, should be sent to the County Welfare Officer, 2, Palace Road, Kingston-on-Thames, as soon as possible. E5535

SUDAN GEZIRA BOARD

ASSISTANT EXPERIMENTAL ENGINEER

The Sudan Gezira Board invites applications for the post of ASSISTANT EXPERIMENTAL ENGINEER. Applicants should be not more than 25 years of age and single. They must have served a full apprenticeship, including draughtsmanship, with a recognised engineering firm and must be capable of developing schemes in full detail.

Starting salary would be in the region of £E800 per annum plus a cost-of-living allowance, which is reviewed quarterly. Appointment will be on short-term contract for a period of three to five years and a gratuity will be payable on termination of the contract. Outfit allowance and free passage on appointment. There is at present no income tax in the Sudan.

Terms of service and application forms will be sent on receipt of a postcard only, addressed to the Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Asst. Experimental Engineer 2413" and name and address in block letters. E5491

PUBLIC APPOINTMENTS

ROYAL DEVON AND EXETER HOSPITAL

ENGINEER-IN-CHARGE

Royal Devon and Exeter Hospital, Exeter, ... applications for the post of ENGINEER-IN-CHARGE at a salary of £500 by £15 (4) by £... to £600.

Applicants should have served a full engineering apprenticeship, hold the Higher National Certificate in Mechanical Engineering, First Class B.O.T. equivalent certificate, have a sound knowledge of steam raising plant, A.C. distribution, low pressure heating, hot water supply and steam distribution design, be competent draughtsmen and capable of controlling staff. The successful candidate will be responsible under the Group Engineer for the maintenance and operation of the engineering and electrical services, &c., of the Royal Devon and Exeter Hospital, West of England Eye Infirmary, Mowbray House Maternity Hospital. The appointment is subject to satisfactory medical examination and Health Service superannuation regulations. Accommodation (unfurnished flat) within reach of the hospital is available on a service tenancy agreement.

Applications, stating age, education, qualifications, experience, &c., with copies of two recent testimonials, to the Hospital Secretary by 31st October, 1953. E5...

NATIONAL COAL BOARD

SCOTTISH DIVISION

WORKS PLANNING AND PROGRESS ENGINEER

Applications are invited for the post of WORKS PLANNING and PROGRESS ENGINEER at a new engineering works at Alloa, in the Scottish Division of the National Coal Board. Candidates should have experience in modern methods of work flow, production control and time and motion study in relation to the large-scale overhaul and maintenance of plant and machinery. Technical qualifications equivalent or superior to the Higher National Certificate in Mechanical Engineering are desirable.—Applications, together with two recent testimonials, and giving full particulars of training, practical and technical qualifications, experience (in chronological order), present post, salary, and salary required, should be sent to the Establishments Officer, 1, Eglinton Crescent, Edinburgh, 12, within seven days. E5...

ELECTRICAL ENGINEERING POSTS

CENTRAL ELECTRICITY BOARD FEDERATION OF MALAYA

A number of ELECTRICAL ENGINEERING POSTS (various categories) are vacant in the Board. Salaries, &c., between £1197 and £... according to experience and dependants. Option of appointment either (a) on agreement for three years with prospect of permanency, or (b) on contract for three years with gratuity of £200/£280 a year. Option to terminate appointment in either case at end of first year, if desired. Free passages. Liberal leave on full salary. Candidates, preferably Grads. or Corp. Members of the Institutions of Electrical or Mechanical Engineers, must have had sound training and appropriate experience. It may be possible to preserve superannuation rights in certain cases.

Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/28770/Eli... E5...

NATIONAL COAL BOARD

SCOTTISH DIVISION

MANAGER

Applications are invited for the post of MANAGER of a new engineering works at Alloa, in the Scottish Division of the National Coal Board. The works will be mainly employed on the large-scale overhaul and repair of electrical and mechanical plant and machinery associated with coal mining and on limited manufacture of general engineering products and steel structures. Candidates should therefore have experience in the most modern methods of planned overhaul of plant and should be capable of organising the works for the processes outlined. Experience in the control of staff and personnel also desirable. There will be approximately ... workmen.—Applications, together with two recent testimonials, and giving full particulars of training, practical and technical qualifications, experience (in chronological order), present post, salary, and salary required, should be sent to the Establishments Officer, 1, Eglinton Crescent, Edinburgh, 12, within seven days. E5...

NORTH THAMES GAS BOARD

DRAUGHTSMEN

The following drawing-office staff are required by the Chief Engineer's Department, Westminster:—

(i) SENIOR DRAUGHTSMAN, experienced in the design of gas manufacturing and ancillary plant, including steel-frame structures. Starting salary depending on age and qualifications, within the range £645–£795 per annum.

(ii) DRAUGHTSMAN, experienced in the layout and detailing of gas manufacturing and ancillary plant, including steel-frame structures. Starting salary, depending on age and qualifications, within the range £520–£695 per annum.

The successful applicants will be required to join the staff pension scheme. Applications, stating age and giving full particulars, should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, London, W.8, to reach him not later than 14 days after the publication of this advertisement, and quoting reference 666/105. E5...

THE ENGINEER

OCTOBER 2, 1953

London-Chelmsford-Southend Railway Electrification

A DECISION to extend the existing Liverpool Street–Shenfield electrification to Chelmsford and to Southend (Victoria) was announced by British Railways last Saturday. The new electrification will consist of 9½ miles from Shenfield to Chelmsford and 21¼ miles from Shenfield to Southend at a total cost of about £2,500,000. When electrification is complete it is expected that the standard journey time of the regular-interval electric services from Shenfield to Southend, with six intermediate stops, will be one hour, but there will be faster trains at peak periods. Twenty-two electric trains between Liverpool Street and Shenfield will be extended to Chelmsford, giving a 50 per cent increase to the present local service. The trains will be of a new design to suit the requirements of daily travellers as well as holiday visitors, and will consist of four-coach, all-steel units, each providing 373 seats. Of the 354 third-class seats, 145 will be in "open" vehicles with central passageway and the remainder will be in compartment coaches. It is emphasised by British Railways that the extension of the existing Liverpool Street–Shenfield electric services forms an essential and preliminary step to the larger scheme of electrification from Fenchurch Street to Tilbury and Southend (Central). Technical planning for this larger electrification is now well in hand, but important engineering works will first have to be completed on the Fenchurch Street line, including the reconstruction of Barking Station, the rearrangement of tracks with a "fly-over," and the construction of a large new marshalling yard. These works will take some years to complete. On the other hand, the extension of electrification from Shenfield to Chelmsford and Southend is a straightforward scheme, with no major engineering works, which it is hoped can be finished by January, 1957. Fast electric services should, therefore, be already running on the Southend–Liverpool Street route by the time the big engineering works on the Fenchurch Street line begin to cause come delays on that route. It is expected that the reserve capacity of the electrified Liverpool Street line will then be of considerable benefit to Southend travellers.

Chemical Research Laboratory

ON Tuesday, September 22nd, the Chemical Research Laboratory of the Department of Scientific and Industrial Research held an open day. The research work of this laboratory is divided into six sections, which include the corrosion of metals, and the organic, inorganic, microbiology, high polymers and radio-chemical groups. Work on corrosion and its prevention underground is proceeding and the problem of high-temperature oxidation is being studied with a view to satisfying the need for a steel of low alloy content for use in boiler superheaters for final steam temperatures above 950 deg. Fah. Corrosion tests under low and high speed conditions in aqueous solutions were demonstrated, and it was noted that the technique used for removing surface films from metals had been improved by the use of Formvar resin as a reinforcement. In the inorganic group the search for rarer elements, such as germanium, gallium and selenium in waste products is of special interest, and selenium, which is used in the electrical, glass and colour industries has been obtained from the flue dust from flush roasters using pyrites. Experimental work on phosphate fertilisers showed that sukula apatite from East Africa, when treated with sulphuric acid solution, was a new source of phosphate supply. The "Respektra" spectrographic calculator was shown and is used to expedite the difficult calculations in quantitative spectro-chemical analysis involving a number of variables. In the new building of the micro-biology group there was a laboratory demonstration of the production of sulphur from sewage sludge by supplementing with sulphate. This method is estimated to yield 15,000 lb of sulphur from 5,000,000 lb of sludge. In the new building which houses the radio-chemical group the recovery of gold from cyanide solutions by ion-exchange was shown and there was also to be seen the determination of copper and cobalt in soils, the determination of uranium and thorium in ores, and a geo-chemical method of prospecting for niobium ores. In another laboratory studies are being made on the effect of variations in polymer structure on equilibria and kinetics of ion-exchange, for the purpose of assessing the suitability of resins in various practical applications.

Jubilee of the Rugby Engineering Society

RUGBY ENGINEERING SOCIETY celebrated its jubilee by holding a conversazione and exhibition in the Rugby College of Technology and Arts on Thursday, September 24th. It was a source of pleasure to all concerned with the jubilee that the company present at the celebrations included Sir William Larke, who was the first president of the Rugby Engineering Society in 1903. The aims of the Society are, briefly, "the promotion of engineering knowledge and study of related scientific information by the reading and discussion of papers, by visits to places of interest, or by other appropriate means." From the outset the Society has had the valuable support of the British Thomson-Houston Company and of Willans and Robinson, and its successor, the English Electric Company. The Society has also enjoyed the close co-operation of the Rugby College of Technology and Arts. Membership of the Society has fluctuated with changing conditions: in 1903 there were 345 members, in 1906 only 100. From 1918 to 1925 the strength rose from 61 to 385, after which there was a decline to about 200 in the mid-'thirties. Since then, however, there has been a steady growth and the present membership, under the president, Mr. A. W. C. Hirst, is 530. Some indication of the scope of the Society's interests was conveyed by the jubilee exhibition, showing fifty years of engineering progress in Rugby. The exhibits were arranged in groups, illustrating the history of the Society and, *inter alia*, power generation, conversion and rectification, motors and alternators, electronics, lamps and illumination, gearing and mechanical measurements, engine ignition, crystal valves, railway engineering, and technical education. Among the exhibits of historical interest were the original impact testing machine made by Izod (who was a Rugby engineer) a Willans steam engine, and a 500 h.p., 25,000 r.p.m. turbine operating at 1500 lb per square inch, which was built in 1923 for use in the early development of the Benson boiler. Exhibits illustrative of more recent progress included, on the one hand, electron-optical apparatus capable of measuring gear tooth surface finish in micro inches, and noise and vibration analysers for the study of gear behaviour under full load conditions. On the other hand, there were exhibits of crystal valves indicating their possibilities in applications as diverse as hearing aids, radar and power rectification.

The Engineers' Guild

THE Engineers' Guild has announced the election of Mr. Henry Nimmo, C.B.E., M.I.C.E., M.I.E.E., as its president for 1953–54. It will be Mr. Nimmo's second year as president, an office which he has accepted at the unanimous invitation of the Guild's council. Mr. Nimmo is particularly well known in electrical engineering circles. He is chairman of the Southern Electricity Board and a part-time member of the British Electricity Authority. Prior to the nationalisation of the electricity supply industry, Mr. Nimmo was for some time chief engineering inspector to the Electricity Commissioners, and in 1945 was appointed a member of the Commission. He has also served as electrical power adviser to the War Office. The Engineers' Guild has also announced the election of Mr. William Linn, M.I.C.E., as chairman of the general council. Mr. Linn, who is the senior partner of Messrs. Cowan and Linn, consulting engineers, of Glasgow, has taken an active part in the establishment of the Guild's Scottish branch. He is a past-chairman of the West of Scotland Association of the Institution of Civil Engineers.

The Volta River Project

A DELEGATION of Ministers and members of the Gold Coast National Committee for the Volta River Project has just concluded a short visit to this country. Prior to arriving in England on September 24th, the delegation, which was headed by Mr. K. A. Gbedemah, Gold Coast Minister of Commerce and Industry, had spent some time in Canada inspecting installations for the production of hydro-electric power and aluminium ingot. The Volta River project, it will be recalled, is a scheme for the large-scale development of aluminium production in the Gold Coast, a total capital expenditure of £144,000,000 being envisaged. The proposal is that the scheme shall be carried through by the Gold Coast Government, the United Kingdom Government, Aluminium Ltd., and the British Aluminium Company, Ltd. On Friday last the members of the delegation visited the Falkirk rolling mills of The British Aluminium Company, Ltd., and were welcomed by Mr. George Boex, joint managing director of the company. In the course of a short speech, Mr. Boex said that the United Kingdom was one of the greatest consumers of aluminium in the world, and that last year in this country nearly 300,000 tons of semi-fabricated aluminium products had been turned out. There could be no doubt that as time went on much more aluminium would be required and it was preferable that it should come from a sterling source. Mr. Boex went on to say that the Volta project was the largest development scheme under investigation in Africa, and that, should it be found feasible, it would enable the United Kingdom to obtain a large tonnage of aluminium to be paid for in sterling. The fundamental advantage of the scheme, Mr. Boex added, was that a large amount of waterpower and a great tonnage of bauxite were available in close proximity; that would help materially to keep down production costs. But, he said, before anything was done, every possible aspect of the Volta project would have been closely examined by the preparatory commission, the Gold Coast National Committee, the governments concerned, and by the aluminium companies.

A Short History of Spectroscopy

By T. W. CHALMERS, D.Sc., M.I.Mech.E.

No. IX—MEASUREMENT OF ENERGY DISTRIBUTION IN THE SPECTRUM

(*Continued from page 387, September 25th*)

STEFAN'S law, $I=\sigma T^4$, gives us the total, or all-wave, value of the energy, in ergs, emitted per second per square centimetre of the surface area of a "black body" or "full radiator" when the body or radiator is at an absolute temperature T.

As a basis of analysis we may assume that the total flux of energy represented by I is the aggregate value of a very large number of elemental parcels of energy each associated with and identified by a separate wavelength. Since the radiator is of the ideal "full" kind the wavelengths of the different parcels will cover a range from zero to an infinitely high value.

It is our immediate object to discuss the manner in which the total quantity of energy

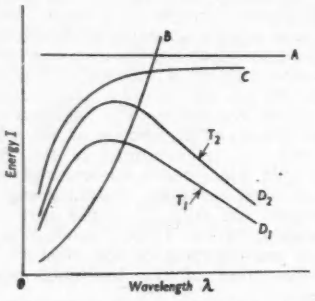


Fig. 27—Possible and Impossible Distribution Curves

is distributed among the different wavelengths of the elemental parcels.

Simple reasoning carries us a good way towards a general solution of the problem. In the first place we can dismiss the possibility that the energy is uniformly divided among the wavelengths as represented by the straight line A in Fig. 27. If it were so, then since all wavelengths from zero to infinity are present the total energy, corresponding to the area under the curve, would necessarily be infinitely great and not of finite amount as stipulated by Stefan's law.

Next we have the experimental fact that, according to Herschel's observations, so far as they went, the heat content of the rays in the solar spectrum increased as he passed from the violet end towards and beyond the red end. The curve of energy distribution must therefore, at first at least, show an upwards rise with increasing wavelength as depicted by curve B, Fig. 27. Obviously, however, it cannot continue to rise indefinitely because if it did the total energy or area under the curve, would again be infinitely great and not finite.

The same objection can be found to a curve of the form C, which implies that if Herschel had carried his observation far enough into the infra-red he would have found that with increasing wavelength the heat content of the rays gradually approached and remained at a limiting value. In such circumstances the total energy would once again have been infinitely great.

There is only one remaining possibility. The distribution curve, as shown at D, must start at a low or zero value, rise to a maximum at some finite wavelength and then fall towards zero again as the wavelength approaches infinity. In these circumstances the earlier part of the curve, preceding the maximum, will agree with the general trend of Herschel's observations while the total area under the curve will be finite as required by Stefan's law.

The curves drawn in Fig. 27 are not intended to have any quantitative significance, but merely to indicate various possible tendencies.

Taking D_1 as representing the general character of the distribution curve, we have now to note an important experimental fact. It is found that the pattern of the spectrum emitted by a heated body is the same at all temperatures. Higher temperatures applied to the radiating body increase the *intensity* of the spectral lines, but do not alter their general disposition.* Observation shows that increase of temperature increases the intensity of *all* the lines present in a spectrum, although all do not show the same proportional increase.

This fact would lead us to expect that if D_1, Fig. 27, is the distribution curve found to hold for one temperature T_1 of the "black body," the curve obtained at a higher temperature T_2 ought to be something like D_2, namely D_1 moved bodily upwards and modified somewhat in shape in accordance with the unequal proportion in which the increased energy is shared among the wavelengths.

Painstaking and difficult experiments, notably those made in 1899 by Lummer and Pringsheim, have confirmed that the energy distribution curves of black body radiation are of the general character sketched at D_1 and D_2, Fig. 27. In outline the experimental method adopted has consisted, as indicated in Fig. 28, of focusing the radiation from a "black body"—in practice usually an electrically heated carbon or porcelain tube A—by means of silver mirrors B, on to a narrow slit at C and then dispersing the radiation by

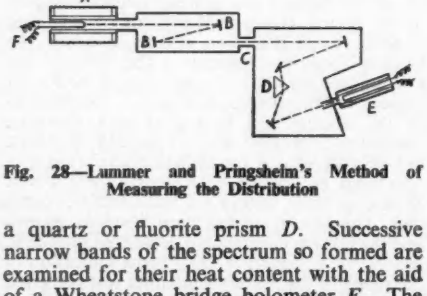


Fig. 28—Lummer and Pringsheim's Method of Measuring the Distribution

a quartz or fluorite prism D. Successive narrow bands of the spectrum so formed are examined for their heat content with the aid of a Wheatstone bridge bolometer E. The heat content is taken to be indicated by the swing of the galvanometer forming part of the bolometer. A thermo-couple F with its hot junction inside the heated tube A measures the temperature of the "black body."

The wavelength of the radiation incident on the bolometer—or more accurately the mean wavelength of the narrow band under observation—is deduced from the known characteristics of the prism D, the zero or fiducial point of the wavelength scale being fixed by an observation of the position of some well-established line in the visible range, such as the yellow line in the spectrum of sodium or helium.

* Increase of temperature may alter the pattern of a spectrum by rendering visible or observable lines which at a lower temperature are too faint to be seen or detected. Again the general statement excludes alterations of pattern produced by temperatures high enough to modify the state of ionisation of the emitting body.

The whole apparatus is enclosed in an evacuated chamber in order to eliminate the absorptive effect of air.

With this arrangement of parts it is possible to measure (*a*) the temperature T_1 of the "black body," (*b*) the wavelength λ_1 of the radiation at any point of the resultant spectrum and (*c*) from a knowledge of the area of the slit at C the intensity I of the energy associated with the selected narrow band.

Comparing the arrangement with that used by Kurlbaum and others for measuring the total or all-wave value of the energy emitted by a "black body" we notice a significant difference. Kurlbaum, it will be recalled, used his bolometer first to measure the temperature of the total radiation emitted by the "black body" and then to measure the energy corresponding to it by cutting off the radiation and by increasing the current through the bolometer to an extent sufficient to produce a heating effect giving the same galvanometer swing as had been shown by the radiation in the first instance. With the arrangement Fig. 28, the significant fact is that the bolometer is used solely to measure the energy of the incident radiation while the temperature of the "black body" is measured separately and independently by the thermo-couple F.

A question of more than mere experimental convenience is here involved. Let us return to our initial assumption that the total flux of energy I from the "black body" is the aggregate value of a very large number of elemental parcels of energy each associated with a separate wavelength. We know from Stefan's law that the total flux I is directly proportional to the fourth power of the temperature T of the "black body."

There is, however, no reason for supposing *a priori* that the temperatures which Kurlbaum's procedure would record for the individual parcels of energy would all be the same and all equal to the temperature T of the "black body." The alternative possibility clearly exists that the temperatures of the individual parcels differ from one to another and that it is their mean value which is recorded when we measure the black body temperature T.

In this respect the kinetic theory of gases provides us with an analogy. The total energy in a volume of gas is the sum of the energies of its individual molecules. The temperature of the gas is represented by the average kinetic energy per molecule.

We will now pass on to describe and discuss the actual experimental results which have been obtained. Fig. 29 shows the energy distribution curves obtained from a black body with its temperature ranging from 723 deg. to 1646 deg. Cent., the wavelengths covered ranging from about 6 microns down to about 1 micron—or just above the beginning of the visible spectrum.

It will be noticed that all the curves are of the anticipated form characterised by the presence of a maximum and that each curve lies wholly above that which proceeds it. From this second fact it is therefore clear that, as was anticipated, the increase of energy radiated from a black body when its temperature is raised is shared among *all* the wavelengths. At the same time the curves show a progressive change in the maxima. As the temperature of the black body is raised the maximum becomes more sharply defined and its position is seen to shift towards the left; that is to say, towards lower and lower wavelength. In other words, while the increased energy produced by raising the temperature of the black body is shared among all the wavelengths, there is a

developing tendency for one wavelength to acquire more than all the others. This specially favoured wavelength does not remain constant. As the temperature rises from 723 deg. to 1646 deg. Cent. the wavelength with which the maximum energy is associated shifts from about 4 microns to about 2 microns.

This shift of the wavelength of maximum energy with increase of temperature accords with the familiar fact that when a body is heated it at first glows with a faint red colour just visible in the dark and then as the temperature rises it passes through bright red to orange, then yellow and finally becomes "white hot." That the final state is "white" and not, so far as can be seen in practice,

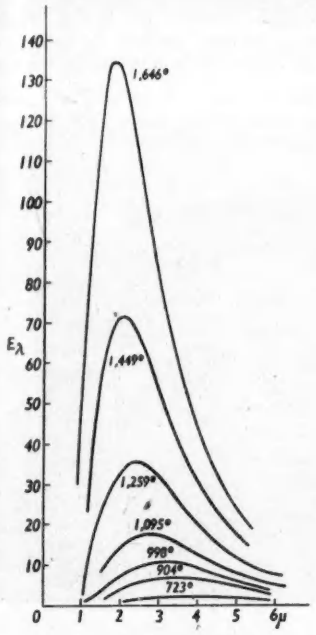


Fig. 29—Experimental Results

violet, is to be explained by the fact that the colour of the heated body is determined by the wavelength with which the energy is *predominantly* but not *exclusively* associated.

The first question to ask ourselves about the curves in Fig. 29 is: Do they harmonise with Stefan's law of total radiation? The answer is that they do. By integrating graphically or by planimeter the area under any one of the curves it is found that the area representing the total, or all-wave, energy, agrees with the formula $I=\sigma T^4$, where T is the temperature of the black body at which the curve was determined.

A second important fact is revealed by Fig. 29. If we designate by the λ_m wavelength which at any temperature T shows the maximum energy then on plotting λ_m against T we find we get a hyperbola. This implies the relationship

$$\lambda_m T = \text{const.} = A \quad . \quad . \quad . \quad . \quad (1)$$

This result is known as "Wien's displacement law" and shows how as the temperature of the black body is raised the maximum energy passes from one wavelength to a lower one. This displacement law is not only deducible from a study of the experimental results: in 1896 Wien showed that, apart from the experiments, it could be deduced from thermodynamic principles.

The experimental results can be studied in another way. If we designate by I_m the maximum value of the energy shown by each of the curves in Fig. 29 and plot I_m against the temperature T, we find that we get a steeply rising curve and that this curve can be represented by the relationship

$$I_m = CT^5 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where C is a constant. This result shows how very rapidly the maximum energy increases with the temperature of the black body, apart from shifting from one wavelength to a shorter value. Wien proved that this second result was deducible from the same thermodynamic argument as had given him his first.

Combining the relationships (1) and (2) we can easily deduce a third, namely,

$$I_m = D/\lambda^5_m \quad . \quad . \quad . \quad . \quad (3)$$

where D is a constant. Alternatively, we may bring the temperature T into the relationship by writing

$$I_m = FT/\lambda^4_m \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where F is a constant.

It might perhaps be thought that (3) or (4) gives us what we are seeking, namely, the law governing the manner in which the energy is distributed in the spectrum of a black body among the wavelengths present in it. This conclusion would, however, be indefensible. The equations relate only to the maxima of the curves in Fig. 29. It would be a very gross mistake to assume that they were true for all other points on the curve. In other words, we cannot discard the suffix m and write (4) as

$$I_\lambda = FT/\lambda^4 \quad . \quad . \quad . \quad . \quad (5)$$

where I_λ is the value of the energy associated with *any* wavelength λ in general.

If the reader asks why we cannot convert the experimentally and theoretically established relationship (4) into the general relationship (5) he may be reminded of an elementary fact. If we are presented with a large number of experimentally determined figures we cannot deduce the law governing them by examining an arbitrarily chosen selection of them and neglecting all the others. From the point of view both of mathematics and common sense it is illogical to deduce a general conclusion from particular results. More specifically we must bear in mind that there may be many different relationships which will fulfil the maxima condition expressed by (4) or (5).

(*To be continued*)

The Third European Machine Tool Exhibition

No. III—(*Concluded from page* 394, *September* 25*th*)

WE conclude below our description of some of the tools shown at the European Machine Tool Exhibition recently held in Brussels.

Liechti and Co.

A new production lathe of somewhat unconventional design developed by Liechti and Co., of Langnau, Berne, Switzerland, is intended for high-speed turning of large chucking work, copying and bar work. It swings up to 25in diameter over the bed and 15in over the tool slides.

On this machine, which is illustrated in Fig. 9, two independent cross slides are provided, and each slide has a rotary table for tool holders, which can be indexed and rigidly clamped. A third slide bridging the two bed ways has mounted on it two copy tables, each with four template stations corresponding to those of the cross slides, and indexed and clamped by the same method.

The slides can be arranged for turning, facing, boring and copying to any profile completely independently of each other. At the rear end of the copy slide is a control panel fitted with push buttons for starting and stopping the spindle, engaging rapid traverse, feed engagement in each direction and on both slides independently. As the machine is fitted with two independent slides with multiple tool stations, the selection of tools with the cutting angles to suit the operation in hand is greatly simplified.

If required the copy slide can be removed and replaced by a tailstock with which shafts up to 15in diameter and 40in long can be adequately supported. When such a tailstock is fitted means are provided for copying independently with both tool slides.

The machine is driven by a 30 h.p. motor

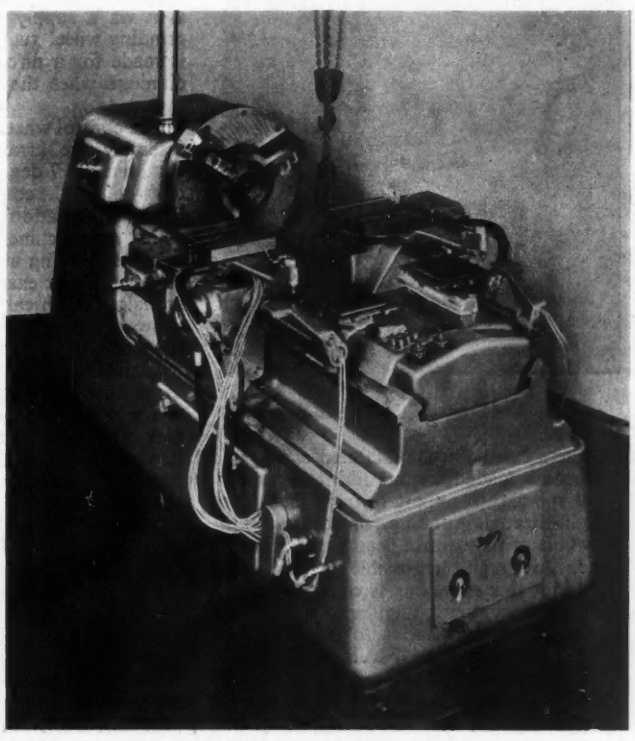


Fig. 9—Production Copying Lathe—Liech

and the drive is taken through a drive unit. This main drive unit is fitted with a compressed-air-operated speed-changing mechanism, and an auxiliary shaft in the unit drives the rapid traverse mechanism for both cross slides.

The headstock assembly incorporates the spindle with its driving gear and a gear which drives the feed boxes. At its side is a rotary knob control for speed and feed selection and a push-button control for the hydraulic clamping mechanism. Twelve cutting spindle speeds from 31·5 to 1400 r.p.m. and seven creeping speeds from 3·15 to 25 r.p.m. are available.

The two independent feed drives are identical, and each has a compressed-air-operated, gear-changing mechanism. The final slide drive is transmitted through splined lead screws, which also serve as feed shafts. Sixteen longitudinal slide feeds from 0·0008in to 0·142in per revolution, and sixteen transverse feeds from 0·0005in to 0·095in per revolution are available.

The representative of Liechti and Co. in this country is Acbars, Ltd., Cecil House, 57A, Holborn Viaduct, London, E.C.1.

B.S.A. Tools, Ltd.

A new centreless grinding machine exhibited by B.S.A. Tools, Ltd., Marston Green, Birmingham, is designed to handle work from $\frac{1}{16}$in to 3in diameter with straight-through or plunge cut operation. By fitting an appropriate attachment, through-feed grinding of bars from $\frac{1}{16}$in to $\frac{3}{4}$in diameter and up to 10ft long can be done.

The new machine replaces the No. 7 model, known as the firm's No. 4 model, and its general arrangement can be seen in the photograph we reproduce in Fig. 10.

The main operational units of the machine are the control wheelhead, the grinding wheelhead and the work supporting base. Feed is imparted by moving the grinding head forward, the control head being fixed. The work base is adjustable so that different

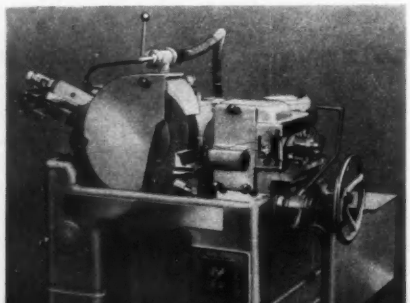


Fig. 10—Centreless Grinder—B.S.A.

diameters can be accommodated easily, and provision is made for either tilting the control wheel spindle, to impart through feed when straight-through grinding, or for swivelling the whole of the control head in a horizontal plane. Although the possible angular movement with this swivelling is only very slight, it allows very small angular correction of the control wheel relative to the workpiece without need for excessive truing of the wheel.

Separate truing slides fitted to the grinding wheelhead and to the control wheelhead are equipped to carry out form truing, if required, by the simple addition of former strips. The grinding wheel truing slide is designed to take a power-drive attachment when necessary. Lateral adjustment of the grinding wheel spindle is made by means of a large micrometer control, and through it quick corrections can be made to the grinding wheel position after any side truing of the wheel.

Drive to the grinding wheel is taken direct, through vee ropes, from the 10 h.p., 1445 r.p.m. main motor, on to the end of the spindle. The grinding wheel runs at a constant speed of 1270 r.p.m. The control wheelhead incorporates a self-contained spindle drive and gearbox unit with directly accessible change gears.

The grinding wheelhead is mounted on one vee and one flat slide, both slides being automatically lubricated, and fully protected against the ingress of abrasive matter.

The wheelhead is moved either by hand wheel or lever, and its base forms a well from which oil is pumped, through a filter, to the bearings. Coolant is fed to the work area via a supply duct incorporated in the grinding wheel guard and separate provision is made for a direct flow of coolant to the diamond when the truing slide at the rear is in use.

The control wheel and its spindle and drive assembly are arranged to pivot up to a maximum of 7 deg. from the horizontal, and the whole of the control head can be swivelled in either direction in the horizontal plane, whilst the machine is in motion. This horizontal swivelling assists when setting up the machine. For example, if when setting for a plain cylindrical component a test piece shows a slight taper, a quick correction can be made by slightly swivelling the control head instead of redressing the wheel. This saves time and reduces wheel wear.

The drive is through worm and wheel and pick-off gears, and additional high speed for truing is obtained by a clutch. The control wheel itself fits directly on to the spindle. A diamond truing slide situated at the rear of the wheel operates in a horizontal plane and remains in the same plane irrespective of the angular position of the control wheel. This wheel has four work speeds from 18 to 59 r.p.m., with an additional speed of 392 r.p.m. for truing purposes.

The work base is adjusted through a micrometer control so that different diameters of work can be easily accommodated by the appropriate setting of the grinding wheel and base. Three kinds of workplate are available, one of chilled cast iron, another of the inserted blade design, and a third of "Stellite."

George Fischer, Ltd.

An interesting group of hydraulic copying lathes was demonstrated in operation by George Fischer, Ltd., of Schaffhausen, Switzerland.

One of this firm's KDM 7/50 machines was equipped with a six-cut recycling device and a swivelling template holder and was shown machining a gear shaft. With the recycling device, up to six consecutive cuts can be taken in one clamping of the work piece. A piece can be turned first from a roughing and then from a finishing template which swivels automatically into position after a predetermined number of initial machining passes have been made. A control drum used on the machine is preset for the machining cycle, such as for cutting length, feed reduction, skip feed, and rapid carriage return. This control drum is quickly interchangeable. A series of drums can be used for batch working and introduced as production dictates without loss of time incurred in setting.

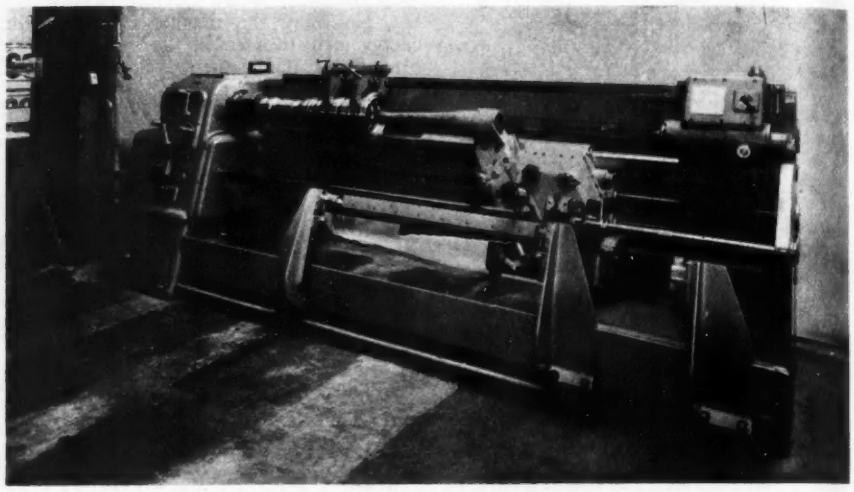


Fig. 11—Machining a Compressor Shaft on a Copying Lathe—Fischer

Another machine shown was equipped for automatic spindle speed changing and fitted with an automatically released hydraulic in-feed attachment. It was arranged for machining components with large differences in diameter and had a special duplex toolholder which permitted successive external and internal copying automatically and in one clamping.

The machine illustrated in Fig. 11 was shown engaged in turning the internal and external profiles on a compressor shaft for a jet engine. As can be seen, the work is supported on roller steadies and the internal machining of the full length of the component is in progress. The shaft being turned is just over 37½in long and 11·6in over its maximum diameter, the furthest extremity of the bore being 5in diameter.

George Fischer, Ltd., is represented in this country by Sidney G. Jones, Ltd., 8, Balham Hill, London, S.W.12.

Wickman, Ltd.

The automatics demonstrated on the stand of Wickman, Ltd., Coventry, included a 1in capacity, six-spindle bar automatic recently introduced by the firm. This machine (Fig. 12) incorporated the firm's

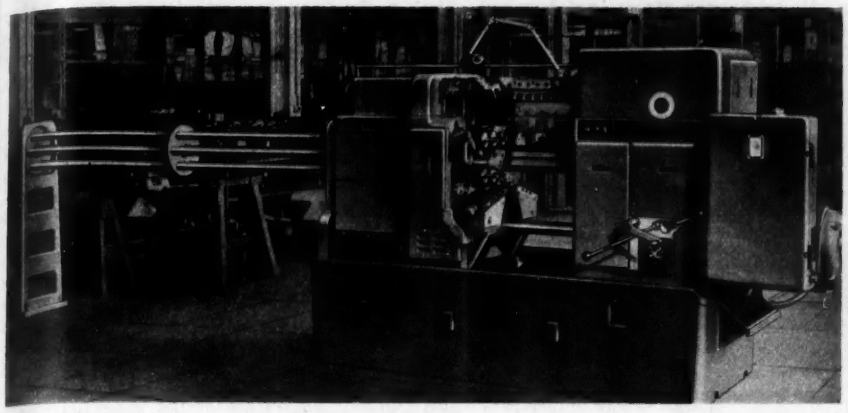


Fig. 12—Six-Spindle Automatic—Wickman

familiar arrangement of autosetting mechanisms by which alterations to the length of tool feed strokes can be quickly made without need for cam changing. In it the mechanism controlling the movement of the centre tool block, and the two auxiliary slides when fitted, is conveniently arranged above the drive housing. A transversely mounted camshaft carries fixed cams and the lever linkage mechanism, the levers receiving their motion from the standard cams. The setting of tool feed strokes merely requires the adjustment of setting blocks along graduated scales fitted to the levers, the fast approach and draw-back of tools being controlled by other fixed cams on the same shaft and remaining constant. Similar mechanisms control the movement of the cross slides, the levers receiving their motion from standard cams on the main camshaft, running longitudinally through the machine. Alterations to cross slides feed strokes are quickly effected by adjustment of the levers along graduated scales fitted to rockers accessibly located behind hinged doors adjacent to the lower cross slides, the fast approach stroke and draw-back of the slides remaining unaffected. A diminishing rate of feed is provided to cross slides to reduce tool pressures in heavy forming operations.

A spindle-stopping mechanism can be fitted when producing large quantities of components requiring side machining operations. In the drum assembly used for this purpose each spindle is provided with a multi-plate clutch and brake with an operating glut controlled by cams mounted round the spindle drum. The clutches and brakes are operated during indexing, and starting and stopping are almost instantaneous.

The spindle drum is indexed by gearing from a geneva wheel, and it is indexed slightly past its final position and smoothly drawn back by a powerful toggle clamp on to hardened locators, where it is positively locked in position. The bar feed and collet operating mechanisms are at the front of the machine, the stroke setting lever for bar feed being quickly adjustable along the T-slot of the cam lever. Standard cams on the camshaft immediately below, control the spring-loaded mechanism, and means are provided for disengaging both bar feed and collet operation in addition to indexing, during setting up.

Drive from the 15 h.p. motor is transmitted to the constant speed shaft by vee belts, and from this shaft by chain drives to the fast motion clutch, speed range change gears and oil pump.

The main camshaft runs longitudinally through the machine and is driven from the feed clutch shaft through mitre wheels and a worm and wheel. In the main drive housing two cam drums are provided for the accommodation of cams for standard and special end-working attachments, and additional special cams may also be fitted on the camshaft in front of the drive housing. Fixed standard cams for cross slides movements, bar stop, bar feed, drum locking, and collet operating are fitted on part of the camshaft which extends into the drum housing. The upper camshaft, controlling the centre tool block (and the two independent longitudinal slides, when fitted) is mounted transversely across the top of the main drive housing.

The machine has twenty-two spindle speeds from 247 to 2510 r.p.m. and its feed range is in nineteen steps.

Dixi S.A.

The "Dixi 60" horizontal boring and milling machine made by Dixi S.A., of Le Locle, Switzerland, is designed to combine the precision of a jig borer with the versatility of a horizontal boring mill. As can be seen in the illustration, Fig. 13, this machine has a particularly rigid double bridged column on which the head is carried on large precision slides and has a travel of 19in. The swivelling table has a surface of 28in by 32in and has a longitudinal traverse of 23in and a transverse traverse of 22in. In each direction the table has a hydraulically operated feed which is variable up to a speed of 78in per minute.

The boring spindle of the machine is driven by a 4·5 h.p. motor through a gearbox providing two speed ranges which, in conjunction with a continuously variable drive, gives a spindle speed ranging from 32 to 1200 r.p.m. Six boring spindle feeds from 0·0015in to 0·01in per revolution are transmitted mechanically. The head is moved up and down on the column by hydraulic power at speeds adjustable up to 78in per minute.

Coarse adjustments of the table and headstock are made by hydraulic power with reference to scales and final fine adjustments are made by hand by using microscopes and precision scales. The swivelling table is also fitted with an optical system with one minute graduations and from which adjustments to within 0·1 minute can be readily estimated.

A particular point which is stressed in the design of this machine is that the speed and accuracy with which the table can be set facilitate the use of very short overhanging boring arbors when machining complementary holes in opposite ends of relatively long work pieces. Instead of using long boring bars and the end support for such work, bores are first machined in one end and the table is then swung round through 180 deg. and, using the same settings, the holes are bored in the other end. To illustrate the machine's capabilities in this connection some interesting examples of long box castings with mating bores machined at each end were shown.

The machines made by Dixi S.A. are handled in this country by Dowding and Doll, Ltd., Greycoat Street, London, S.W.1.

Mägerle Brothers

The grinding machines shown by Mägerle Brothers, Ltd., of Uster, Switzerland, included a heavy-duty precision surface grinding machine arranged for fully automatic operation. This machine is made with three table lengths of 29½in, 41½in and 49½in, each 9 7/16in wide, and having a clearance from wheel to table of 15½in. The table and cross slide are hydraulically operated and incorporate rapid traverse gear.

The grinding wheel head is fitted with automatic downfeed which can be regulated to give from 0·0001in to 0·0005in feed on each reversal of the work table. A special device is fitted to compensate automatically for wheel truing, and a control light provides optical means of setting and indicates

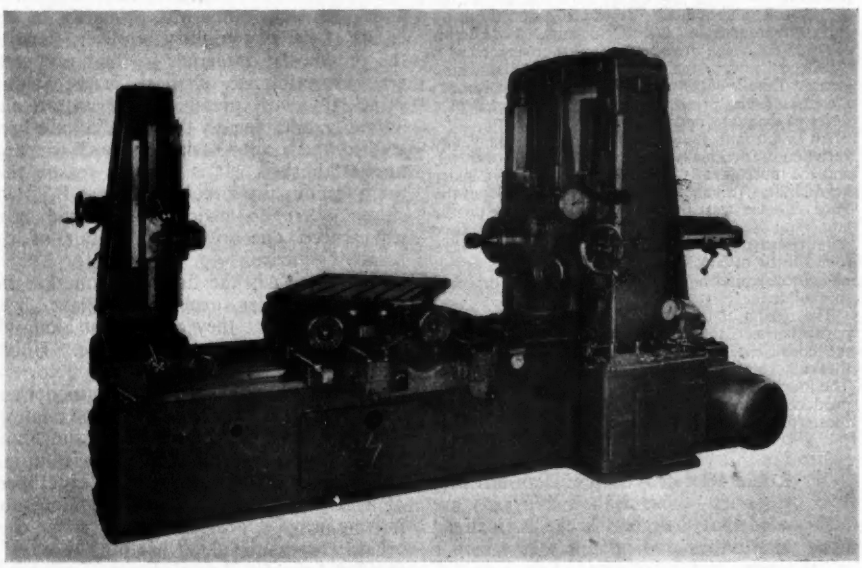


Fig. 13—Horizontal Boring Machine—Dixi

when the finished size has been obtained.

Mägerle machines are distributed in this country by Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.

Heyligenstaedt and Co.

One of the copying lathes demonstrated by Heyligenstaedt and Co., of Giessen, Germany, is illustrated in Fig. 14. This machine is being made in four sizes having lengths between centres from 20in to 60in and has been designed to swing work up to 6½in and 10in diameter over the saddle or 16½in over the bed.

Fig. 14—Copying Lathe—Heyligenstaedt

As can be seen, the main slide carrying the copying attachment and saddle is set at an angle of 30 deg. at the rear of the bed, and the tailstock is carried on ways at the front of the bed. The 25 h.p. main motor drives a three-speed unit through vee belts and an eight-speed gearbox is driven through three magnetic couplings from this three-speed unit to give a range of twenty-four spindle speeds from 50 to 2000 r.p.m. The feed drive is transmitted through a P.I.V. stepless unit giving a range of cutting speeds from 0·004in to 0·03in per revolution of the spindle. A separate motor drive is used for the quick-return movement.

The template is supported above the main slide and a copying attachment of the firm's standard design makes possible the turning of right-angled shoulders, conical and round parts, &c. By means of dogs, adjustable along slots below the template, speed changes can be preselected so that they are automatically engaged whilst the machine is in operation. Transverse as well as longitudinal copying can be carried out on the machine, and by operation of the magnetic clutches in the feed drive the appropriate facing speeds can be engaged as required.

Institution of Naval Architects

No. II—(*Continued from page* 403, *September* 25*th*)

THE I.N.A. meeting in Holland was continued on Tuesday afternoon, September 15th, with Sir Stanley V. Goodall in the chair, the first paper presented being :

TESTS OF LAUNCHING GREASES

By J. Brown, B.Sc.,* and J. M. Ferguson†

Synopsis

An extensive investigation into the frictional properties of launching greases has been carried out for the British Shipbuilding Research Association by John Brown and Co., Ltd., Clydebank. Four series of tests were made, three of which were concerned with "Tallene" grease, the fourth with mineral launching grease. Details of tests, testing procedure and records are given ; the principal results are presented in a series of diagrams and discussed in the text.

An important factor was observed, namely, the variation in frictional values over the first 2ft of travel, and the much greater uniformity for travels of slider beyond 2ft. Valuable results were obtained from the third series of tests in which the force acting on the launching trigger was measured by weighing the force required to "hold" the slider. These forces were found to be of considerable magnitude. This aspect of the tests could be of great interest to the practical shipbuilder.

The results of these tests indicated a striking disparity between the coefficient of static friction and the coefficient of initial sliding friction. A hypothetical explanation of this phenomenon is offered. The fourth series of tests on mineral launching grease produced important results when compared with those for "Tallene."

Discussion

Sir Robin Rowell : Shipbuilders fall into two categories—those whose shipyards are so situated that their berths can be inclined at a comfortable gradient due to the incline of the site, and have plenty of launching space, and those whose yards have limited launching space and may be situated on flat ground, such as those in Holland, where it is important to have as little declivity as possible to obviate the construction of heavily inclined berths and to be able to launch a ship with the minimum velocity when launching into restricted waterways.

In the past the choice of launching tallow and other lubricants was primarily in the hands of the shipwright ; however, some of the present-day materials in their raw state are susceptible to changes in behaviour, principally with pressure, temperature and humidity, and recently these media have been studied and a safer basis of launch preparation established. It is for that reason that the questionnaire circulated by the B.S.R.A. showed that no major trouble had been experienced due to the behaviour of the launching grease.

I think this is the first occasion that the results of slider experiments have been tabulated so that they can be put alongside the results of our own experience. Unlike model resistance experiments, where correlation has been established between model and ship, we have not achieved the same relationship between the behaviour of a slider and the launching of a ship, because it is impracticable to make a slider a scale experiment of a ship. For a ship, both standing and moving ways almost completely cover each other, whereas the slider has only to move a few feet before it is skating upon fresh lubricant. The slider may be regarded as uniformly loaded, whereas for a ship the loading varies throughout the length of the launchways, due to the different weight of the ship per foot run of its length, the flexibility of the ship structure and the ability of the ground and the launch make-up to resist the loads imposed upon it. For an 18,000-ton tanker, if the average grease loading on the ways is 2 tons per square foot, the loading will vary from 1·5 to 2·5 tons per square foot.

A slider is normally turned over upon the launching way, and the weights applied, but for a ship the weight is applied over a period of time, with varying degrees of evenness, and the resulting pressures are not uniform. The authors' experiments have been carried out in a reasonably practical fashion and have led to fairly uniform results in their findings, if we disregard the initial movements of the slider. However, I believe that if sliders of different sizes are used, although the inclines and loadings be the same, completely different results will be obtained.

The curves of launching declivities given by Mr. A. Hiley in 1913 were for varying conditions of load per square foot, with varying increases in declivity for a sure start and slide. The lubricants of the day were commercial tallow, soft soap and train oil, but with present-day lubricants and make-up of ways, declivities considerably less than those given by Hiley can be used. The paper is of value after the slider has been set in motion, i.e. after the first 2ft of movement, but below that there is no consistency at all in the results. In this respect the information given in the paper is absolutely consistent with our experience with the ship, because we have never found any reason for the behaviour within the first 2ft of travel. It does not appear to vary with temperature or loading or declivity of the ways.

The work that I did on the loads on triggers was carried out because we felt that the old theories of initial friction were fallacious, since we had recorded loads upon launch triggers of about 90 to 95 per cent of the resolved free force of gravity, and I feel that when using modern lubricants launch triggers should be constructed to withstand the full unrestricted resultant of gravity plus a margin of safety, because a ship may have to be held upon the berth and launched later. The ship starts to launch hours before the trigger is released, and the launching weight comes up against the trigger.

I am puzzled when I read expressions such as "initial friction," "starting friction" or "stiction," and think that something might be gained by studying the plastic theory as applied to launching lubricants, rather than apply any form of coefficient to the initial friction.

Ir. R. Voorhoeve : I am interested in this subject of launching greases because we always carry out measurements before and during the launching of each ship, such as the creep of the ways and the holding force on the trigger, and calculate the coefficient of friction from the velocity and the acceleration during the launch. From the measured holding forces on the trigger we have arrived at a different conclusion from that of the authors ; our measurements indicated that the holding force on the trigger was about the same as the creep force, from which we concluded that the friction at that moment was zero.

Ir. J. H. Krietemeijer : At the yard in which I am engaged it is normal practice to record launchings and to produce diagrams similar to Fig. 6 of the paper ; therefore it is worth while to pay attention to the co-ordination of the work on launching tests by the British Shipbuilding Research

* Director, John Brown and Co. (Clydebank), Ltd.
† Superintendent, Experimental Tank, Clydebank.

Association, and suggest co-operation in the tests carried out at individual Dutch yards.

Fig. 7 in the paper is plotted with great accuracy and I understand it is for calculating the coefficient of friction at the moment of releasing the trigger; however, the degree of accuracy is too high, for the movement does not start at the actual point of trigger release, but much earlier, for when taking away the blocks and transferring the load to the standing way there are vibrations and changes of pressure which cause creep. In order to be sure that the coefficient of friction is as near as possible to the coefficient of friction at motion, we have a method of enlarging the load on the trigger before the last bilge blocks are removed. A few minutes before cutting the trigger wire and when all bilge blocks are still under load, we depress the forward end of the sliding way, all slack in the ways is taken away and there is the beginning of a slight movement, with the load on the trigger rising. Meanwhile, the last blocks are taken away and the pressure on the forward end of the sliding way is raised. When the last blocks are taken away movement has started, and at that moment the launching signal is given, the trigger is released and the ship is shot away as from a catapult.

Since the war we have used "Esso" launching greases, base coat and slip coat, two layers of base coat and one layer of a mixture of two base coats and one slip coat. The figure given in the paper for the melting of the base coat is too low; we use 240 deg. Fah. and bring up the slip coat on the base coat, not as a thin layer, but in small blobs, leaving air channels in between. With regard to the testing procedure followed by the authors, I believe the tests were made with uniform time of loading before the trigger was released, we vary the time before releasing the trigger and loading the ways, and find that the longer the ways are under load, the bigger is the holding force on the trigger.

Dr. S. Livingston Smith: An important factor influencing the launching of a ship is the performance of the launching grease, yet little reliable information is available in this field, and the paper helps to fill this gap in our knowledge. The results of the tests supply some useful data; but the tests were made on a model slipway and it is desirable to compare the results with the data obtained from a full-scale launching operation.

A suitable instrumentation for the accurate measurement of the forces acting during launching and for obtaining time-distance curves has been developed by the B.S.R.A., and we have made a number of measurements and the results are available. Some of the ships were launched with "Tallene" and others with mineral greases, and good agreement with the authors' results has been obtained for ships launched on "Tallene," but the results with mineral greases emphasise the importance of the time the ship is permitted to remain on the trigger before launching.

With regard to the general conclusions, that mineral grease gives a lower coefficient of static friction and therefore a higher load on the triggers, I feel that the time must be sufficient for this situation to develop. In our experiments on full-size ships on two occasions launching on mineral greases actually gave a higher coefficient of static friction and lower load on the trigger than for ships launched on "Tallene." This appears at first sight to be contradictory to the conclusion reached by the authors, but it is almost a verification, because in these particular instances the ships were on the triggers for only a few moments, and consequently there was no time available for the full development of the load on the triggers.

Another factor is that it is reasonable to expect that the full trigger load will develop earlier on the short model than on the much longer ways in full-scale launching. The examples I have mentioned with regard to the measurement of creep during the launching indicated that movement continued up to the moment of release, so that the full load on the triggers had not been reached.

This leads to the conjecture that when mineral grease is used the magnitude of the forces acting on the launching triggers, and the coefficient of starting friction may be regulated by selecting the length of time during which a ship is left on the triggers. The longer the time, the larger will be the force on the triggers and the smaller the coefficient of starting friction. The rate of build-up of the forces on the triggers is of vital importance and it is hoped to obtain information from observations on full-scale launches which are to be made by the B.S.R.A.

Professor Ir. H. Blok: An important gap has been filled in our knowledge of launching greases, but another important gap has yet to be filled. It seems that difficulties have been experienced in arriving at a generally applicable interpretation of test results, especially as regards the relationship between the frictional performance of the greases and their rheological (flow and deformation) characteristics. I make two suggestions to overcome the difficulty of this correlation. First, we may regard the experimental set-up used by the authors as a scaled-up model of the parallel plate viscometer used in laboratory determinations of the rheological characteristics of greases. If more were known about those characteristics of the greases tested, such as their yield values and their trends of shearing stresses with varying rates of shear, perhaps certain of the authors' friction results could be interpreted in a more synoptical way, and conclusions reached which are more generally applicable. The second suggestion is the application of dimensional analysis along the lines used for correlating friction determinations in oil-lubricated journal bearings with sliding speed, oil viscosity and bearing load.

Mr. Brown, in reply: We are not wedded to any conceptions of values of coefficients of friction, and although we have referred to coefficients of initial sliding friction and coefficients of static friction, these are rather terms of convenience. Like most shipbuilders, we relied on Hiley for many years, but felt that more extensive knowledge of the subject was required. Encouraged by the B.S.R.A. we undertook these tests and were led to the need to turn attention to the initial forces rather than the derived coefficients of friction. Therefore do not put too much stress on these terms, but bear in mind rather the development which has arisen in the course of the work, of thinking in terms of the holding forces.

There seems a desire to associate the build-up of the forces with the time the loading is actually on the triggers before launching, but practice in the different shipyards varies in regard to the number of blocks left below the ship before launching, and that must be a major factor in the load coming on the triggers.

As to scale effect, it would be interesting to test the results with varying sizes of slider, but I do not think that it would be of great value, for the results from the slider seem to lead primarily to plotting curves of coefficients of friction. We are getting away from that to the question of the actual holding forces. We realise that the model test is an idealised launch as compared with the irregular distribution in the ship, and that again ties up with such things as the method of wedging up and with the number of blocks. Nevertheless, used as a yardstick, it has served its purpose to point this new development of giving attention to the initial forces.

On this question of variation of pressure, in a book by Sir John Biles there is a discussion on the elastic ways as against the normal conception of rigid ways on which most shipbuilders base their calculations, and if you base your calculation on the elastic ways you arrive at enormous pressures. Therefore, calculations with regard to varying pressures would be rather fruitless.

Professor Krietemeijer mentioned that his practice has been to make a regular study of the ship results, but the study of ship results produces a different approach from that of the model tests. The model tests have shown this difficulty of plotting time-distance curves, and this must apply to the full-size ship, and it will have to be abandoned as a method of analysis of launches unless something more is known about the switch-over from the conditions at rest to the conditions of movement.

In reply to Dr. Livingston Smith, I suggest that the irregular results with mineral greases might be due to variations in the launch conditions, particularly in the number of blocks left below the ship.

Viscount Runciman was in the chair on Tuesday afternoon, when the second paper was read. It was:—

OPTICAL MARKING-OFF SYSTEM FOR PLATES AND SECTIONS IN SHIPBUILDING

By Ir. J. H. Krietemeijer

Synopsis

The application of the optical marking-off system for plates and sections in shipbuilding during the last five years has proved that there are certain advantages over the classical method. An analysis of this classical marking-off method is given and, further, the new method is described in full. A comparison is made between the two systems showing clearly the advantages of the optical method. Special attention is given to the advantages regarding man-hours, cost and space. A few examples of man-hour calculation are given. Reference is made to the application of the method in several shipyards. The arguments which have led to the introduction of the system into the reorganisation of the yard in which the author is engaged are dealt with. A few remarks are given in connection with the expected further development of the system, especially in face of the new fully automatic marking-off and oxy-acetylene flame-cutting machine. A list of references is added.

Discussion

Dr. E. C. B. Corlett: What is the effect on the eyes of the draughtsmen of the extreme accuracy necessary in the drawing and of having to use optical aid to improve visual acuity? My second question concerns the curved receiving plane. There is a 3in curvature in a large plate, which is not much, but surely it is possible to overcome this by optical methods, such as the use of a curved projection plane in the projector. A high-grade flexible film is reliable and does not shrink. If the projection plane in the projector were curved instead of the receiving plane on the marking-off table it would enable the direct marking-off of slabs on a frame to be done; and the statement in Section 8 of the paper, that "A few shipyards still use a scrive-board near the bending slab on which the body plan or part of it is transferred," indicates a considerable disadvantage because it means duplication of work.

You have an elaborate optical apparatus and a very highly developed drawing-office system and yet men are working on the marking-off tables with centre-punches and other crude methods. In the aircraft industry

they project directly on to sensitised plates. The saving effected in labour would probably more than compensate for the cost of putting an emulsion on the plate and altering the black-out arrangements to suit and it would be possible to mark off the plates in seconds, once the image was in focus. The author has listed the advantages of the use of the system but there is another which cannot be overlooked, and that is in a new yard it is cheaper to arrange for optical marking-off than to employ the normal system. Apart from the saving in space there is a saving in first cost.

Ir. G. De Rooij: Is there any special training for the optical draughtsmen? Are the draughtsmen interested in the new method or are they sceptical about it, and does working with magnifying glasses tire the eyes? Are the advantages of the optical method the same for the small yard as for a larger one? And what is the minimum capacity of a yard which would warrant the installation of the system?

It is possible that the work in the shops will set up vibrations in the projector installation, and what is the effect of such vibrations on the acuity of vision and the sharpness of the image?

Ir. D. E. D. Romijn: The lines on the scrive-boards have a thickness of 0·10mm when drawn on a scale of 1 : 10, but the projected lines of the image on the plate still have a thickness of 1–1·5mm, although they are sharp.

The marking-off apparatus is rigidly mounted on the roof of the platers' shop, but the height of the projector above the marking-off table is 14m. The machines and the cranes in the platers' shed will cause a steady vibration of the lines and there is also a slight deviation caused by the prevailing strong westerly winds, which will move the shed some millimetres so that I wonder if the lines will be projected and marked off accurately enough to satisfy the high demands of the Bureau of Ships of the Navy.

Professor Ir. H. E. Jaeger: I am pleased that I was able to encourage Mr. Krietemeijer to apply the optical marking-off system in his yard at Flushing. The disadvantage of a welded ship is the inevitable shrinkage of the plates, but one of the big advantages of the optical marking-off system is that it can be so applied as to take the shrinkage into account immediately.

A method which has been adopted by a yard in Holland is to use a mathematical formula to put the lines on the board. If you use this method, for which Mr. Rösingk is responsible, in connection with this optical system it can be done directly and accurately in the drawing office.

Mr. M. F. Gunning: It has occurred to me that the system described by Mr. Krietemeijer might have a very great effect on shipbuilding in war-time if it were properly organised beforehand. If not only the drawings had been available, but also the provision for marking-off the plates of the ships, there would have been a saving of time extending into weeks and months at a time when the ships were needed very urgently.

Ir. Krietemeijer, in reply: Dr. Corlett asked about the effect of the use of magnifying glasses on the eyes of the draughtsmen. We have had no difficulties in that respect, and I have heard that in a Belgium yard where the draughtsmen have been using magnifying glasses for three years, their eyes have become better instead of worse. It was mentioned by Dr. Corlett that the rounding of the marking-off table was 3in, but that is not so; it is 3cm. We have thought of the system he proposed of rounding the tables on which the drawings are laid and then photographing, but it has not been developed to a high degree, although there may be developments in that direction. We also thought of providing the plates with a sensitive layer but it is too expensive. I know that it has been used in the aeroplane industry, but its application is very difficult in shipbuilding, where the plates are rather rough in comparison with the aluminium plates used in aircraft construction.

I agree that when establishing a new yard the optical marking-off system is cheaper to install and more economical to use than the normal method.

It is our practice, when applying new methods or systems, to inform our people beforehand; I have done that by lecturing to our workmen so that they know what is going on. Some of the markers employed in the shop thought that we might dispense with their services, but we use them on the welding floor. The men who have become draughtsmen are more keen now to develop new methods than they were when working in the yard.

I believe the optical system can be used in the small yards, with small projectors, as well as in the big yards with larger projectors. The problem of vibration is important and difficult to solve. The ideal solution would be to build a separate tower for the projector but it is expensive and after consideration we decided to build the cabins on the roof. Experience at several yards has shown that small vibrations do not matter. One yard made an investigation, using artificial vibrations; the projected lines, instead of being 1·5mm thick were 3mm and sometimes 4mm thick, but the workmen could mark off the centre of the line with an accuracy just as high as when there was no vibration. Several yards, however, have built their projectors in separate buildings.

It is not often possible to use a whole section, consisting of several plates, under the projector, because most sections are too big; the area covered by one projector may be as much as 12m by 4m. However, there is a system using four projectors together and four slides in each projector, in order to cover a larger area such as 15m by 8m, but the rounding of the table presents difficulty.

To Mr. Romijn I say that we can satisfy the high demands of the Bureau of Ships of the Navy and at the same time ask if those demands could not be reduced, because it is not necessary for such a high degree of accuracy in fabricating the hulls of ships.

(To be continued)

Performance and Efficiency Tests on S.R. Diesel Electric Locomotive

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E.

No. I

The test bulletins issued by the Railway Executive covering stationary and road trials of various steam locomotives have created widespread interest. These bulletins have now been followed by the first relating to a main line diesel-electric locomotive, and in this article and a succeeding one the author reviews these tests and analyses some of the results.

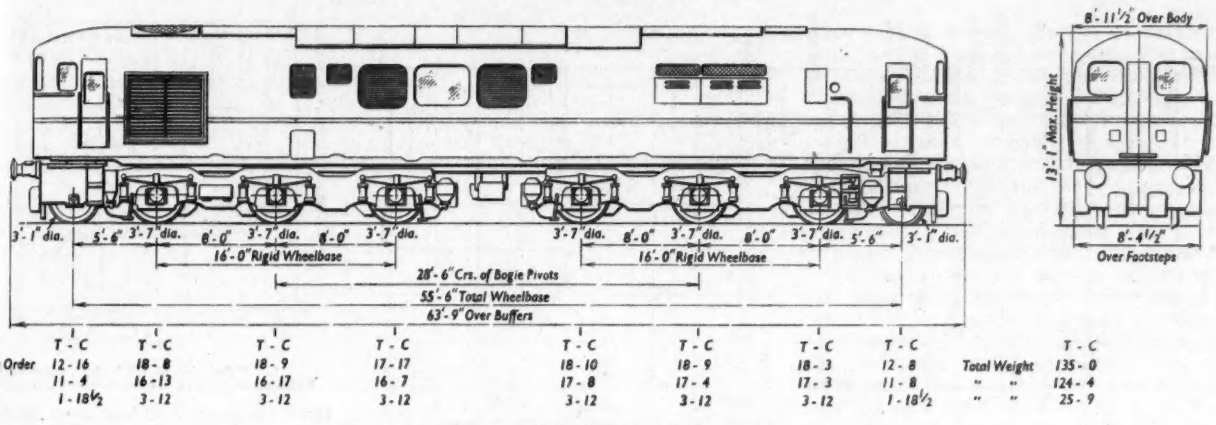
EVER since the phenomenally rapid change from steam to diesel-electric locomotion on the American railways began, engineers in this country have sought authoritative data whereby the relative economic advantages of steam and diesel-electric traction might be compared on the fairest possible basis. So often it has been felt that new diesel power has been compared with out-dated steam locomotives, while on other grounds there is evidence that the American motive-power metamorphosis has been dictated by other than strict engineering or economic considerations. But now, in the latest bulletin to be issued by the Railway Executive, information is available whereby diesel-electric performance may be compared with that of efficient, modern steam locomotives in first-class condition; the reports have been compiled under precisely the same code of testing procedure, and the majority of the steam locomotive bulletins issued so far have been compiled from the work of the team of test engineers also responsible for the diesel-electric tests. The results are thus strictly comparable. In the introduction to the bulletin itself it is stated that this is the first to be published dealing with a non-steam locomotive, though actually a most interesting report was issued in 1952 dealing with tests on the Brown-Boveri gas turbine locomotive No. 18000, running on the Western Region. This report was reprinted in full in THE ENGINEER of May 16, 1952. As with the tests at present under review, the road trials were made with the Western Region dynamometer car.

The diesel-electric locomotive tested was one of two of the 1 C_o–C_o 1 type ordered by the former Southern Railway, and all the trials described in the bulletin were carried out over the West of England main line between Waterloo and Exeter Central. The tests conducted were in two groups:

(*a*) Observational tests on revenue earning trains to obtain average performance and efficiency values in representative service.

(*b*) A series of analytical tests, to obtain the basic fuel consumption related to the drawbar tractive effort and horsepower, in some way analogous to the obtaining of the characteristic curves of the steam locomotive performance by tests on the stationary plant, and by controlled road tests at constant evaporation.

During both groups of tests a precision oil meter of the positive displacement type was fitted in the fuel line, together with a thermometer for measuring the temperature of the oil as metered. The meter registered electrically on the distance-base and time-base charts of the dynamometer car. The outputs of main and auxiliary generators were observed at short time intervals by metering equipment arranged on the locomotive. In addition, the engine speed, exhaust temperature, cooling water outlet temperature and lubricating oil temperature, and pressure were kept under observation. The instant of taking each observation was marked



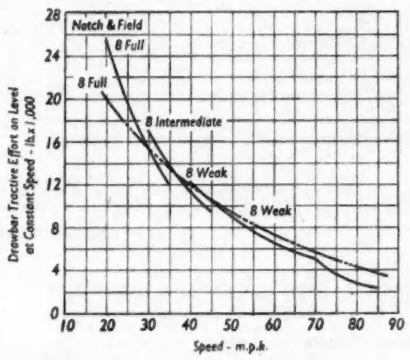
Weight :-	T - C	T - C	T - C	T - C	T - C	T - C	T - C	T - C		T - C
In Working Order	12 - 16	18 - 8	18 - 9	17 - 17	18 - 10	18 - 9	18 - 3	12 - 8	Total Weight	135 - 0
Empty	11 - 4	16 - 13	16 - 17	16 - 7	17 - 8	17 - 4	17 - 3	11 - 8	" "	124 - 4
Unprung	1 - 18½	3 - 12	3 - 12	3 - 12	3 - 12	3 - 12	3 - 12	1 - 18½	" "	25 - 9

Fig. 1—Front and Side Elevations of Locomotive

electrically on both time-base and distance-base records ; against these the values were afterwards written, so that complete co-ordination of all measurements and observations was secured.

A longitudinal and front elevation of the locomotive is shown in Fig. 1, and the leading dimensional details together with the designed performance and efficiency are given in Table I.

Before coming to a discussion of the actual tests results a brief reference to the normal work of these locomotives may be made. Nos. 10201 and 10202 are employed on express passenger trains between Waterloo and Exeter, and between Waterloo and Weymouth ; each makes two return trips per day, six days a week, involving normal daily mileages of 687 on the Exeter route and 571 on the Weymouth route. Reference is made later in these articles to some runs in ordinary service, as distinct from test conditions. The gas oil used had a gross calorific value of 19,610 B.Th.U. per pound ; all the samples were found to comply with the requirements of B.S.S. 209 : 1947 for class "A" fuels for oil engines, and the cost of the oil as delivered into the fuel tank of the locomotive was 1·63d. per pound, at the time of the service trials, and 1·69d. at the time of the analytical trials.

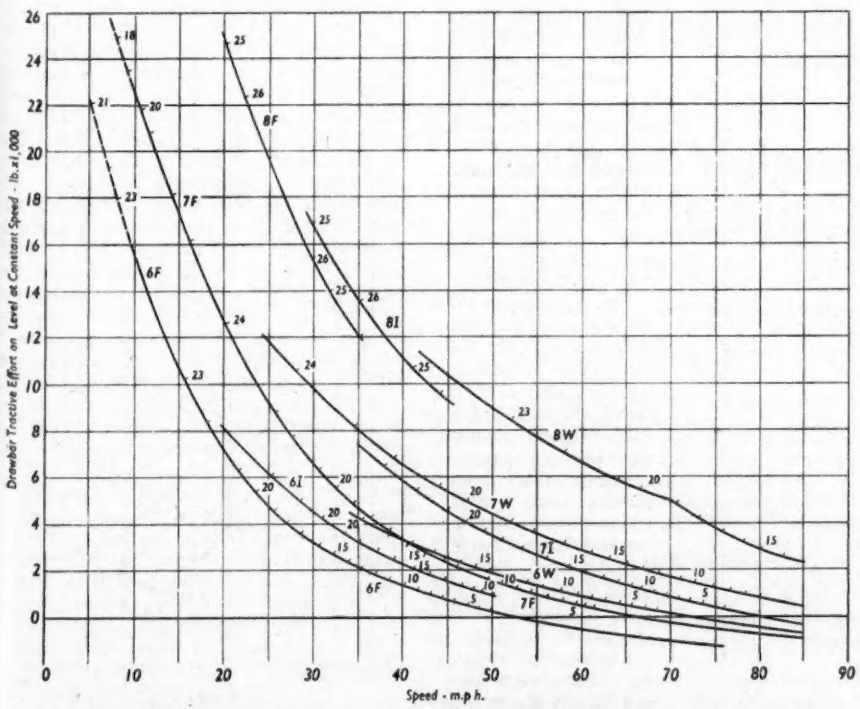


Note.—Original arrangement : gear ratio 52 : 21 and one stage of field weakening, as on service tests — chain line. Present arrangement : gear ratio 65 : 17 and two stages of field weakening, as on analytical tests – full line.

Fig. 3—Effect of Altering Gear Ratio and Introducing an Additional Stage of Field Weakening

Analytical Test Results

The drawbar tractive effort characteristics of the locomotive for the higher notches of the controller are shown in Fig. 2. These cover the sixth, seventh and eighth notches—the eighth being the highest. As originally designed and intended for high-speed passenger schedules the gear

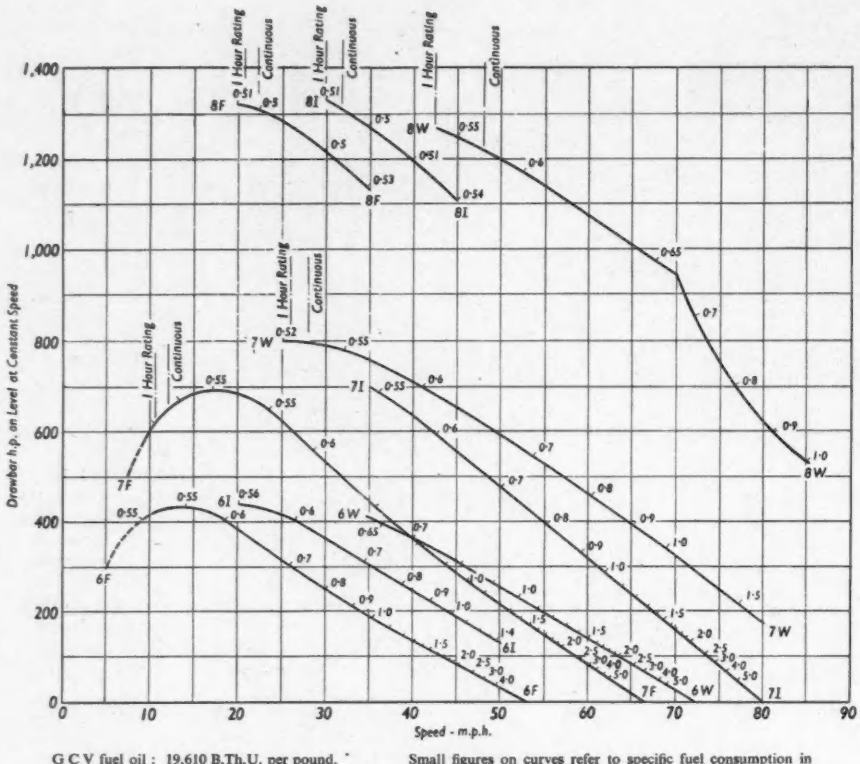


G C V fuel oil : 19,610 B.Th.U. per pound. *Note.*—Small figures give efficiency at drawbar, based on inclusive fuel consumption. Large figures give controller notch position and field strength : F, full ; I, intermediate ; W, weak.

Fig. 2—Drawbar Tractive Effort Characteristics with Efficiencies

Table I—*Leading Particulars, Designed Performance and Efficiency and Principal Dimensional Details and Ratios of the Locomotive*

Locomotive as at present and as at the second or analytical series of trials	
Wheel arrangement	1 C–C 1
Length over buffers	63ft 9in
Weight in working order	135 tons
Maximum tractive effort at rail	48,000 lb up to 8·75 m.p.h.
Continuous tractive effort at rail	21,700 lb at 24·5 m.p.h.
Diesel Engine	
Maker	English Electric Company
Type	"16SVT/I," vee type, turbo-pressure charged
Rated output	1750 b.h.p. at 750 r.p.m.
B.m.e.p. at rated output	122·5 lb per square inch
Designed brake thermal efficiency	32·5 per cent at full load
Corresponding fuel consumption	0·396 lb/b.h.p./hr
Cycle	Four stroke
Cylinders :	
Number	16
Bore	10in
Piston stroke	12in
Valves :	
Per cylinder	1 inlet, 4 ⅛in diameter; 1 exhaust, 3 ⅜in diameter
Combustion chamber	Open type
Pistons	Aluminium alloy
Gas rings	Three, top ring chrome-plated
Scraper rings	Two, S.O.C. type
Speed at full load	1500ft/min
Speed at maximum revolutions	1590ft/min
Maximum cylinder pressure	800 lb/sq in
Cylinder liners	Wet type, cast iron
Exhaust temperature, from cylinder	850 deg. Fah. full load
Exhaust temperature inlet to turbine	1000 deg. Fah. full load
Superchargers :	
Number	4
Maker and type	Napier, "T.S.100/3"
Speed at full load	17,000 r.p.m.
Boost pressure at full load	4·5 lb/sq in
Main and big-end bearings	Copper - lead - lined steel shells
Bearing oil pressure	50–60 lb/sq in
Fuel injection equipment	C.A.V. and Bryce
Nozzle blow-off pressure	2500 lb/sq in
Weight of engine generator set complete	65,350 lb
Main Generator	
Maker	English Electric Company
Type	"E.E.823A"
Continuous rating at 750 r.p.m.	1155kW, 1650A, 700V
One-hour rating at 750 r.p.m.	1155kW, 1750A, 660V
Maximum current	3000A
Number of poles	8
This machine has one bearing at the commutator end.	
Auxiliary Generator	
Maker	English Electric Company
Type	"EE.909A"
Continuous rating, 435–750 r.p.m.	45·9kW, 340A, 135V
Number of poles	6
This machine is overhung on an extension of the main generator shaft and has no bearings.	
Traction Motors	
Maker	English Electric Company
Type	"EE.519/4D" (series wound)
Number	6
Continuous rating	550A, 350V, 750 r.p.m.
Gear ratio	3·82 : 1 (65 : 17)
Maximum rotational speed	2550 r.p.m.
Number of poles	4
Connections	Three groups of traction motors in parallel across main generator, each group consisting of two motors in series
Field shunting :	
First stage	55 per cent of full field
Second stage	31 per cent of full field
Method	Non-inductive shunt
Ventilation :	
Method	Forced
Quantity of air	1500 cu ft per min per motor
Locomotive as at the First or Service Series of Trials	
The gear ratio was 2·48 : 1 (52 : 21) and only one stage of field shunting was employed ; this was to 45·5 per cent of full field.	

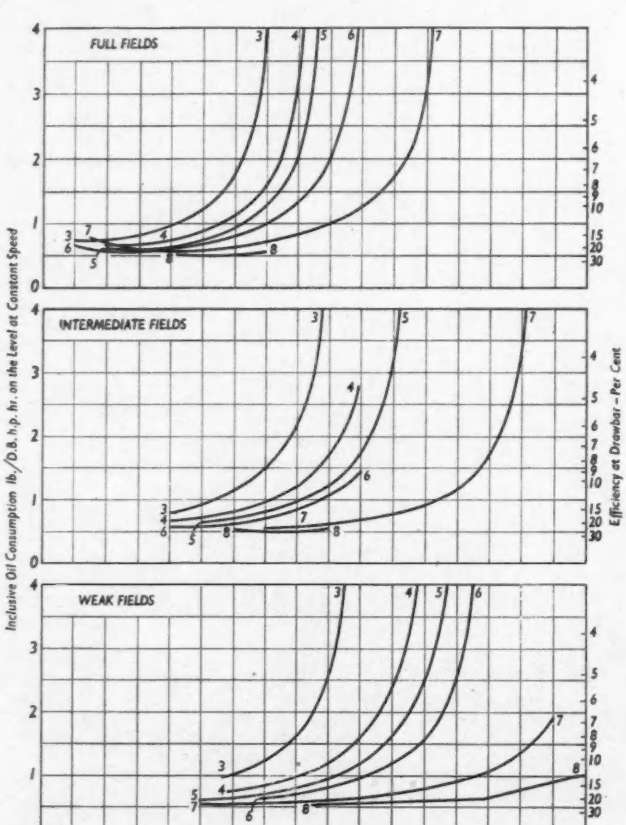


G C V fuel oil : 19,610 B.Th.U. per pound. Small figures on curves refer to specific fuel consumption in pounds per drawbar horsepower-hour, i.e. inclusive fuel consumption divided by drawbar horsepower. Large figures refer to controller notch position and field strength. F, full ; I, intermediate ; W, weak.

Fig. 4—Drawbar Horsepower Characteristics

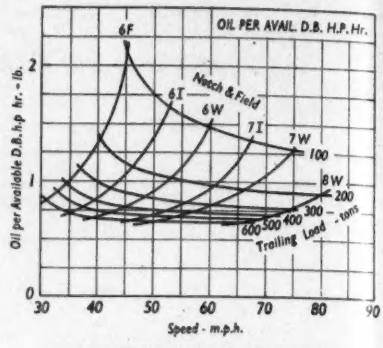
ratio was 52 : 21 with one stage of field weakening. The present arrangement, with a gear ratio of 65 : 17 with two stages of field weakening, was adopted to obtain greater power in acceleration. The analytical tests were carried out with the locomotive in this condition. The changes in tractive effort characteristics resulting from this change in design are shown in Fig. 3. It will be seen that the drawbar tractive effort on the level at 20 m.p.h. is increased from 20,000 lb to 25,000 lb in notch 8, while there is no appreciable difference at speeds between 35 and 50 m.p.h. Although the automatic change - over from one degree of field weakening to another is more clearly marked with the present arrangement than with the original, and may take place at any speeds within the overlap of the curves, no operating disadvantages were noticed as a result of these effects.

Fig. 4 illustrates the drawbar horsepower characteristics for the same three notches as for the tractive effort curves shown in Fig. 3. The bulletin includes similar diagrams covering the lower powers and speeds, which are covered by working in notches 3, 4 and 5. A study of these diagrams shows that a considerable choice of notches is available when working at these low powers —a feature that is useful when working loose-coupled goods trains. At the higher


FULL FIELDS
INTERMEDIATE FIELDS
WEAK FIELDS
Inclusive Oil Consumption lb./D.B.h.p. hr. on the Level at Constant Speed
Efficiency at Drawbar - Per Cent
Speed - m.p.h.

G C V fuel oil : 19,610 B.Th.U. per pound. Figures on curves refer to controller notch position.

Fig. 5—Inclusive Oil Consumption and Efficiencies

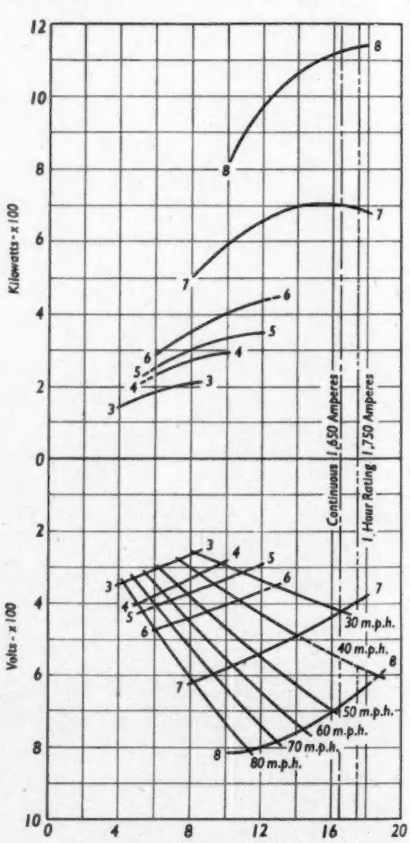


G C V fuel oil : 19,610 B.Th.U. per pound.
Examples of cost in oil of different train loads and speeds.

Fig. 6—Passenger Service on Level Track ; Oil Consumption/Speed Curves

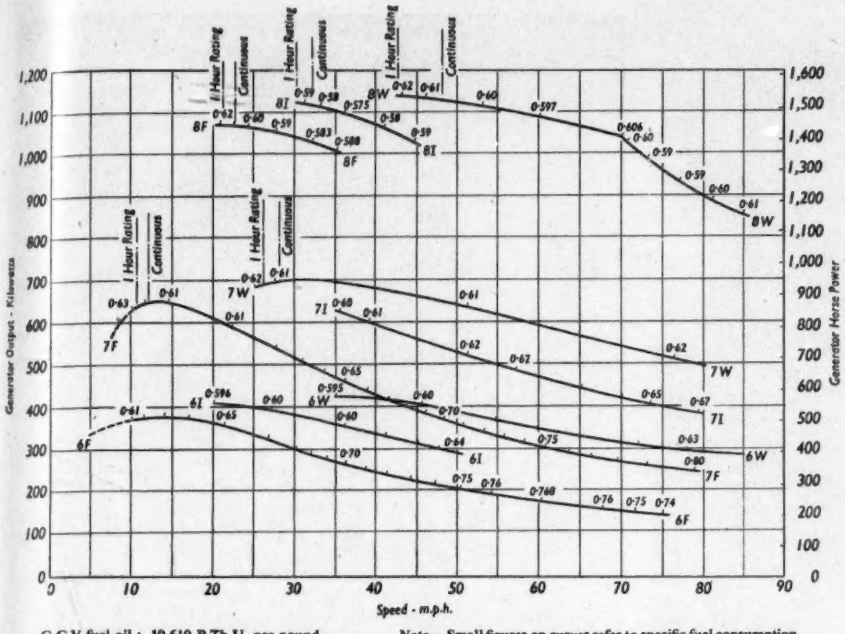
powers, as illustrated in Fig. 4, there is a part of the power range that is not well divided by intermediate notches ; it is pointed out in the bulletin that in certain conditions of service this " gap " might lead to some loss of flexibility, and it is a point to which some attention is recommended if future locomotives of this type are constructed.

The high optimum efficiency of the diesel-electric locomotive is one of its major attractions as a motive power unit, and the graphs included in Fig. 5 cover the entire range of power output with notches 3 to 8 inclusive. It will be seen that whereas the efficiency is well maintained over the entire speed range at high output, there is a very rapid falling off, even with notches 5 and 6, after a speed of 40 to 45 m.p.h. is attained. This, at first, might suggest that with ordinary revenue-earning trains, with the incidental slowings, periods of easy running, and so on, that are inseparable from day-to-day service the overall efficiency would be poor ; but, as will be



Figures give controller notch position.

Fig. 7—Main Generator Characteristics ; Weak Fields



G C V fuel oil : 19,610 B.Th.U. per pound. *Note.*—Small figures on curves refer to specific fuel consumption in pounds per kilowatt-hour, i.e. inclusive fuel consumption divided by main generator output. Large figures refer to controller notch position and field strength. F, full ; I, intermediate ; W, weak.

Fig. 8—Main Generator Output Characteristics

TABLE II—*Comparison between Fuel Costs of Different Forms of Motive Power for Particular Duties*

Type of locomotive	Average train load, tons	Unit cost of power or fuel as delivered to locomotive	Thermal efficiency fuel to drawbar, per cent	Cost of fuel	
				Pence per mile	Pence per draw-bar horsepower per hour
Electric : S.R. locomotive, No. 20003, Victoria–Newhaven ...	436	1·06d. per kW per hour at third rail	11·5	20·8	1·28
Diesel-electric : S.R. locomotive, No. 10202, Waterloo–Exeter	350	1·51d. per lb	18·8	12·8	1·05
Gas turbine : W.R. locomotive, No. 18000, Paddington–Plymouth...	360	1·10d. per lb	6·6	27·7	2·27
Steam : W.R. " Castle " class, Paddington–Plymouth	360	0·37d. per lb	5·5	12·6	1·18

shown later, the trains on which the service trials were conducted, and which form a part of the normal duties of one of the Southern locomotives, were almost ideally suitable, and yielded overall efficiencies varying between 17·6 and 19·6 per cent.

From the graphs in Fig. 5 it will be noted that the oil consumption per drawbar horsepower-hour in notch 6, with a weak field, rises from 0·6 lb at 35 m.p.h. to no less than 4 lb at 68 m.p.h., with a drop in efficiency to less than 3 per cent, while in notch 7, with a field of intermediate strength, the overall efficiency drops from 15 per cent at 60 m.p.h. to 4 per cent at 75 m.p.h. Such characteristics emphasise the need for most careful selection of duties for diesel-electric locomotives if full advantage of their optimum thermal efficiency is to be realised. By way of contrast, reference to an earlier bulletin dealing with the " Hall " class 4–6–0 of the former Great Western Railway—a motive power unit of roughly comparable power—the coal per drawbar horsepower-hour varied only between the narrow limits of 2·4 lb and 4 lb over a speed range from 20 to 60 m.p.h., and a power output on the level extending from 350 to 1000 drawbar horsepower. Although the optimum thermal efficiency of the steam locomotive is much lower than that of the diesel it is maintained fairly constantly over a far wider range of power output. The oil consumption characteristics of the diesel in notches 6, 7 and 8 are shown in relation to speed and to trailing load in Fig. 6.

In a lecture to the Graduates' Section of the Institution of Mechanical Engineers last year, Mr. R. A. Riddles quoted the comparative fuel costs for electric, diesel-electric, gas turbine and steam locomotives in ordinary service shown in Table II.

According to the test bulletin on the Southern locomotive No. 10202 the cost of gas oil has risen from the 1·51d. per pound quoted by Mr. Riddles a year ago to 1·69d. Even with an overall efficiency of 18·8 per cent the diesel showed no appreciable cash saving over steam, and on train services less favourable to the locomotive than those on which No. 10202 was actually tested this equality would probably disappear. In general utility service, with diagrams including a mixture of light and heavy duties, there is every suggestion that a modern steam locomotive would show lower fuel costs in present British conditions.

Turning now to the electrical equipment, the main generator output characteristics are shown in Fig. 8. These curves reflect the drawbar horsepower characteristics of the locomotive itself, as shown in Fig. 5, while one set of curves of generator current and voltages are shown in Fig. 7. The maximum measured output of the main generator was 1145kW at 635V, 1803A in the weak field of notch 8 at a train speed of 42 m.p.h. At this rate of working the combined output of both main and auxiliary generators was 1190kW, and the generator efficiency is 94 per cent. The corresponding brake horsepower of the engine is 1690, and in these conditions the oil consumption is 0·417 lb per brake horsepower-hour. With oil having a calorific value of 19,610 B.Th.U. per pound, this gives a brake thermal efficiency of 31·1 per cent at maximum output. A still higher efficiency of 33·4 per cent was obtained, in the intermediate field of notch 8 at 36 m.p.h.

These analytical tests were made with special trains over the Southern main line between Salisbury and Exeter Central. The loading of the trains was arranged so as to permit the use of notches down to No. 3. The smallest load used was 61 tons, for working in notches 3 and 4, and the largest 390 tons for notches 7 and 8. Up to the time of commencement of the analytical tests the locomotive had run 130,310 miles, and the engine hours totalled 3890. Prior to this the locomotive had received an intermediate overhaul consisting of tyre turning, change of gear ratio, and certain minor mechanical alterations. The diesel engine was inspected, and only four pistons were withdrawn. No parts were replaced, and no decarbonisation was carried out.

(*To be continued*)

Electrical Manufacturing Extensions in Loughborough

Improved manufacturing and testing facilities have recently been installed at the works of the Brush Electrical Engineering Company, Ltd., Loughborough. They include a new machine for the balancing and overspeed testing of alternator rotors, a new single-storey building for the manufacture of switchgear and control gear, and extensions to the company's research laboratories.

ON Thursday, September 24th, a party, including Sir Harold Roxbee Cox and representatives of the British Electricity Authority, consulting engineers and the Press, visited the Brush Electrical Engineering Company, Ltd., at Loughborough to see the company's new rotor balancing machine, switchgear factory and research laboratories.

The visit began with a short tour of the turbine shop, where interest was focused on the new machine for balancing and overspeeding alternator rotors and for balancing at machine speeds the combined alternator rotor and overhung blade system of Ljungstrom turbo-alternators.

With the equipment previously used for these operations it was necessary with rotors weighing up to 7 tons, first to correct the balance in a balancing machine by shaft markings and trial-and-error estimation of the adjustment required. The rotor was then transferred to the overspeed pit for overspeeding and then returned to the balancing machine for check balancing. Heavier rotors were balanced in the overspeed pit using an electronic apparatus made by the company's development section, but it required expert knowledge to achieve an accurate balance in a reasonable number of trial runs.

The new Avery machine is designed to enable a more accurate balance to be obtained in a much shorter time. It will now be possible accurately to balance an alternator rotor, check the balance at machine speed, overspeed and recheck at machine speed. It will also be possible to mount the overhung blade systems on the end of the alternator rotor to balance the completely assembled rotating system.

The Balancing Machine

The overspeed pit in which the new balancing machine is installed has a total length of 61ft.

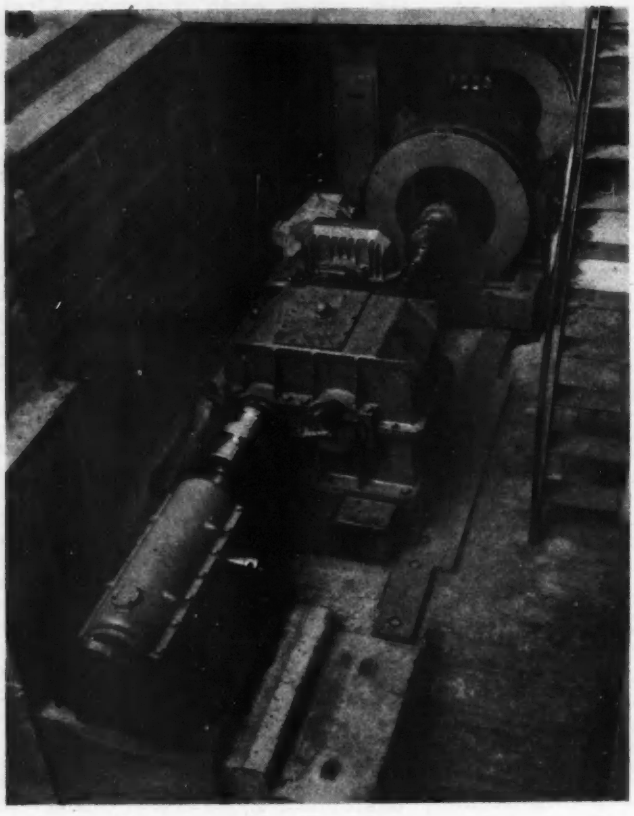


Fig. 1—Motors and Driving Gear in Overspeed Pit

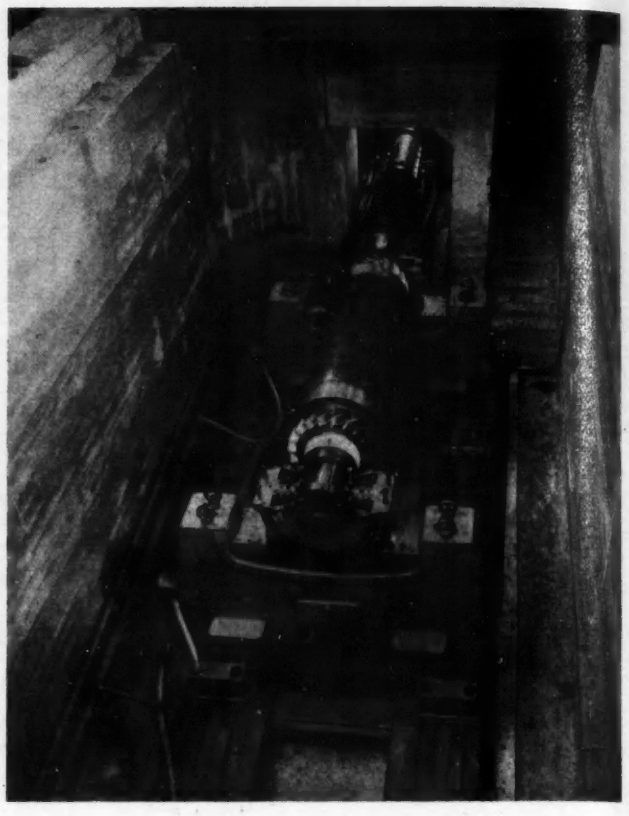


Fig. 2—Balancing Machine in Overspeed Pit

It is divided into two chambers. One (Fig. 1) houses the driving equipment and the other (Fig. 2) the balancing machine. The power is supplied by tandem d.c. motors giving an output of 1350 h.p. This power is transmitted to the balancing machine by a two-speed gearbox to give speeds suitable for 1500 and 3000 r.p.m. machines. A worm drive barring gear is provided to turn the rotor at 10 r.p.m. and to assist in the starting of heavy rotors. The main pit, housing the balancing machine, is 14ft deep and is covered by removable sections of steel and concrete beams.

Two sets of bearing mountings are provided : the first is for balancing short stiff rotors of 50 tons at speeds of 180 to 1800 r.p.m. and 14-ton rotors up to speeds 3600 r.p.m., and the second is for balancing long flexible rotors up to 20 tons at 3800 r.p.m. With the first set of bearings the machine will accommodate, with housings, rotors 24ft 9in long from drive coupling to outer bearing centre, and, with the second set, rotors 24ft 9in long from drive coupling to outer bearing centre.

Both the gearbox and the balancing machine have separate oil systems and there is a hand oil pump to allow the machine to be brought to rest in the event of failure of the main lubricating system.

The rotors are driven through an adjustable connecting shaft which is coupled through a universal joint to the end of the rotor. The connecting shaft also drives a phasing generator for balancing and a speed indicator transmitter which operates an indicator in the control room. To each bearing Lead is attached a moving coil electrodynamic pick-up which monitors the vibration due to unbalance. The outputs from the phasing generator and from the pick-ups are fed into a wattmeter on the control desk. Wattmeter readings are taken with phase differences of 90 deg. and from these is obtained the magnitude and position of the unbalance. The sensitivity of this system is 0·0002in to 0·00004in eccentricity of centre of gravity according to the weight of the rotor.

The control switchgear and indicating gear is installed over the motor compartment, and the control desk and indicator desk are in a control cabin 12ft 6in above floor level. The control desk carries the regulators and meters of the Ward Leonard speed control, a master interlocking switch, control buttons and an emergency stop button. The interlocking switch is operated by a " Castell " key which is available only when the safety gate between the motor room and pit is closed and locked.

On the indicating desk are mounted the balancing instrument, the bearing housing locking controls, bearing oil temperature indicators, bearing oil pressure gauge and the alarm light system. Green lights indicate current switched on to alarm gear, to main oil pump motor and to gearbox oil pump motor. Red lights indicate loss of pressure in gearbox oil system and low oil level in the bearings emergency oil supply tank. Both red lights are interconnected with a " Klaxon " horn which can be silenced by a cancellation switch.

Switchgear Manufacture

A new single-storey building has recently been put into commission for the manufacture of switchgear and control gear, and a tour of this department was included in our visit to Loughborough. Much of the switchgear made here is metalclad equipment for voltages up to 15kV and rupturing capacities up to 350MVA. Outdoor circuit breakers for 33kV, with rupturing capacities of 750MVA, are also made. For low-voltage systems the company also manufactures

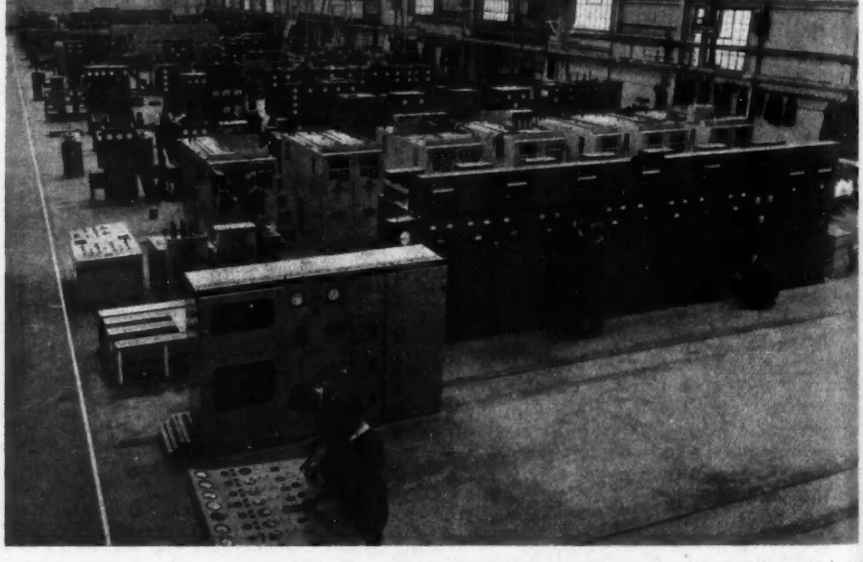


Fig. 3—Main Switchboard Erection Bay

industrial circuit breakers, h.r.c. fuse switchgear, and special control gear for traction and marine service.

Facilities for doubling the output of these products are available in the new building, which has a workshop floor area of about 150,000 square feet. To reduce handling costs all materials sub-assemblies, finished components and bought-out equipment are fed through a centrally placed store to the erection bays disposed around it. The erection bay for large switchboards (Fig. 3) has an area of 41,000 square feet and that for fuse switchgear and control gear 15,000 square feet. Sub-assembly and fabrication sections account for about 56,000 square feet. Machining is done in central machine shops feeding all product divisions of the Loughborough works. Completed multi-panel switchboards can be loaded from either of the two principal erection bays with equal facility. Approximately half the roof area of this workshop is of glass and artificial lighting is provided by a combination of mercury-vapour and tungsten filament lamps. All interior steelwork is finished in aluminium paint and the walls in cream.

In the main erection bays there are twenty-nine switchboard building lines at 11ft centres to allow ample working space for assembly and manœuvre for despatch. The lines will accommodate up to twenty-five ordinary panels. These switchboard building lines are for erection of the kind of switchboard upon which there are many variables, which determine the time they are likely to occupy the floor. Some switchboards, however, are made in large quantities (for Brush diesel alternator sets, for example) and are highly standardised. They are erected on bogies running on floor rails with component parts drawn from containers alongside. At the ends of the floor rails equipment is provided for electrical circuit testing, over-potential, and for insulation measurement.

At one side of the fixed building lines is an area in which circuit breakers are assembled upon trucks for metalclad switch units prior to their incorporation in switchboards. In this area are master jigs for truck mounted circuit breakers and housings.

Fabrication of the steel structures for metal-clad switchgear and control cubicles is in a separate building adjacent to a covered stock-yard for steel plates and sections. Many of the structures are of welded constructon and are standardised. In this shop there is a multi-turret press with thirty-two punches of different size and shape in a horizontally rotating head. Steel plates in which holes are to be formed are moved on a table arranged to traverse in two directions under the punch head. The press operator has push button control of the rotary head to select the desired press tool, and manual control of the table traverse, with direct indication of hole position from a datum line. Plates are punched by this tool without the necessity for laborious marking out and drilling.

Electrical testing before despatch takes place in an enclosure at the despatch end of the erection bays. Here there is a transformer for voltage testing up to 100kV and current transformers for heat runs, &c., up to 3000A. Multi-circuit socket outlets connected to a plug board in the test area are available at convenient points throughout the erection areas so that much of the electrical testing can be done, as it must, during erection in the building lines. The test equipment includes transformers with "Variac" control, mounted on rubber-tyred trucks, and designed for primary injection testing and flash testing. Other trucks carry instruments for testing current transformers and for checking synchronising equipment.

Production control, progress and planning, and foremen's offices are arranged along one side of the shop, clear of the assembly area. There is a separate workshop for development and research. It is under the control of a chief development engineer and is administered independently of the production shops.

Research Laboratories

The company was among the first of its kind to recognise the importance of scientific control in industry, by setting up a works laboratory in 1908. This part of the organisation has grown continuously and the laboratories have recently been extended as we saw on our recent visit.

Broadly, the work of the laboratories may be grouped under six headings. The first is chemical or spectrographic analysis. The second is concerned with the mechanical strength and physical properties of the materials used in manufacture; for this purpose the laboratories are equipped with tensile and compression testing machines, an Izod testing machine and hardness testers. The third group is electrical and magnetic testing and, in association with this group, there is a separate laboratory for high-voltage and corona discharge testing. The fourth heading includes applications of electronics in vibration measurements and stress analysis investigations; we noted bench equipment for the photo-elastic stress analysis of, for example, turbine blade roots. The fifth group is concerned with metallographic investigations and the laboratory is equipped for microscopical examination and X-ray diffraction as applied to the study of crystal structure.

Finally, there are facilities for radiographic examination by X-rays or by the use of radio-active isotopes. To supplement these facilities use is made of ultrasonic testing equipment for detecting flaws, in turbine rotor forgings, for example.

An Aluminium Alloy Bascule Bridge

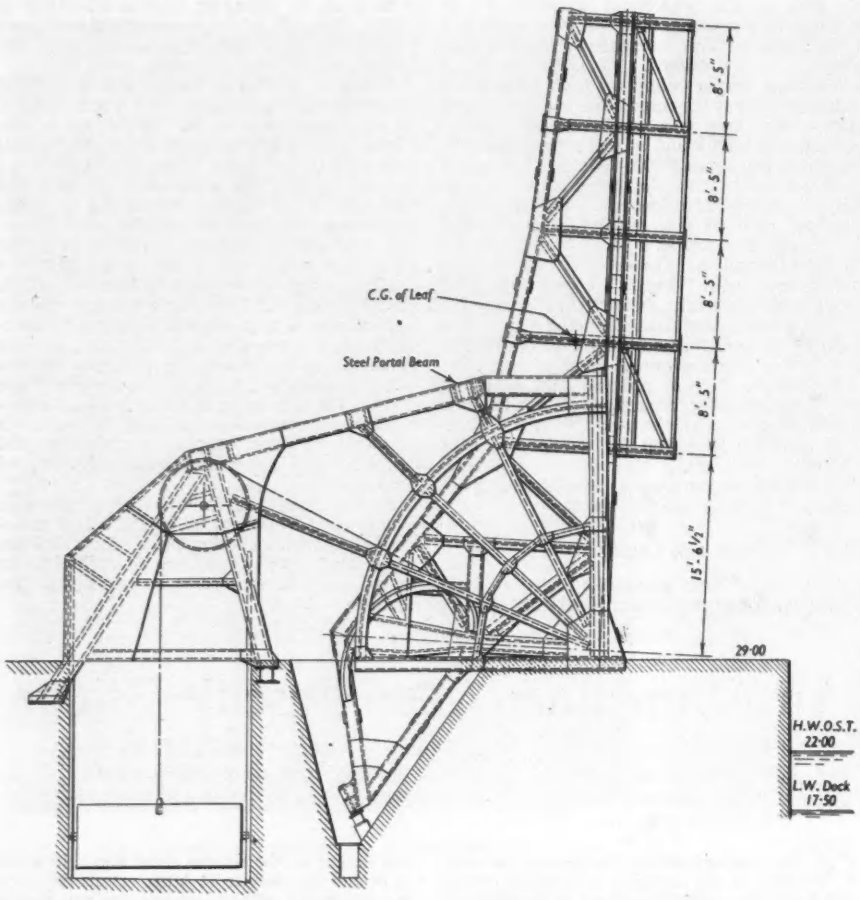
A double-leaf bascule bridge spanning 100ft was opened at Victoria Dock, Aberdeen, on Wednesday last, September 30th. The movable spans are of aluminium alloy, and their construction has involved novel methods of fabrication, operation and counterbalancing.

ON the morning of last Wednesday two new bridges at the entrance of Victoria Dock, Aberdeen, were officially opened by Her Majesty Queen Elizabeth the Queen Mother. The opening ceremony marked the completion of the first stage of a scheme for the development of the port of Aberdeen, works to the value of £1,000,000 having now been carried out by the Aberdeen Harbour Commissioners. The bridges form a modern traffic link between the north and south sides of the Victoria Dock. They serve the nearby deep water berth and will facilitate the rapid turn-round of shipping and relieve road congestion elsewhere.

A number of problems had to be faced before deciding on the types of the bridges which had to be built. The north lock is permanently sealed at its seaward end with a concrete dam and is used by vessels being fitted with engines and boilers at the nearby shear legs. In order to extend this service to large vessels requiring the full length of the lockway the new bridge spanning the 57ft north lock has been made removable. A simple steel deck span was chosen for the north lock, which may be removed from its concrete abutments by lifting on a buoyancy pontoon. The pontoon is built up from fourteen "beetles," which were previously used for the support of the floating roadway of the D-Day Mulberry Harbour.

The bascule bridge spans the south entrance to the Victoria Dock, which is separated from the north lock by an "island" about 70ft in width. Victoria Dock is the principal commercial dock and communicates with the upper dock. Thus, the construction of the new bridge was not allowed to interfere with the passage of shipping through the dock from the start to

Double-Leaf Bascule Bridge at Victoria Dock, Aberdeen



Fixed Steel Structure and Bascule Leaf in Raised Position

finish of the work. The limited space available at the site dictated that the bridge should occupy the minimum ground space. Concentrations of weights had to be reduced to economise in foundation costs and the bridge had to be speedy in operation, driven by simple machinery, with low operating costs, present a pleasing appearance and be immune from damage by shipping when in the fully open position. In order to meet all these requirements, Mr. John Anderson, the Aberdeen harbour engineer, developed his double-leaf heel trunnion bridge employing aluminium alloys in the moving spans. Each moving leaf rotates about a trunnion at the landward end, the trunnions being set at 100ft centres. The contract for the final design, construction and erection of the new bridges was entrusted to the Head Wrightson organisation. It may be recalled that in 1948 Head Wrightson and Co., Ltd., built the first aluminium alloy bascule bridge in the world at the entrance to the Hendon Docks, Sunderland*; the present bridge is the second bascule bridge to employ aluminium alloy.

A good idea of the appearance of the completed double-leaf bascule bridge is given by the photograph reproduced on page 429, and the three accompanying drawings show the structure in more detail. It will be observed that a deep pit to house the counterbalance weights has been avoided by carrying the weights over a pulley bearing on a steel frame behind the span, the pulley rope passing round a cam built into the moving leaf; the cam gives the correct lever arm for all positions of the leaf. This arrangement is clearly shown in the diagram, where the positions of the cam when the leaf is both raised and lowered are shown; the side elevation of the bridge in the raised position also shows the balance weight system. The avoidance of the customary deep pits was particularly advantageous with the site conditions encountered.

The operating machinery for lifting the leaf is housed inside a portal beam, which has a cross section about 5ft square and forms part of the leaf. A pinion wheel driven by this machinery engages with a rack on the quadrant of the steel fixed structure. The clean lines of the completed bridge are well shown in our first illustration, from which it will be seen that the fixed steel structure has been treated with aluminium paint, giving a uniform appearance to the whole work. The photograph reproduced on page 431 shows the shop erection of one of the moving leafs. The portal beam for the operating machinery is not in position in this illustration, but the hole in the main truss for the pinion wheel drive can be clearly seen, thus indicating the position of the portal beam.

The bridge was designed to carry road and rail traffic. A 22ft wide roadway is provided between the trusses, whilst outside the trusses there are walkways 5ft wide for pedestrian traffic. The total weight of aluminium alloy used in the movable spans is 48 tons. The flooring system employed is that of cross girders carrying troughs, the wells of the troughs being unfilled. To the tops of the troughs are bolted Rhodesian teak underlay timbers some 3in thick, tongued and grooved and laid diagonally. The rails, of standard gauge, are set to one side of the bridge and are bolted through the teak underlay to the tops of troughs. Douglas fir dowelled paving blocks 5½in deep form the road surfacing and they are coach screwed to the teak underlay. In the two leaves there are approximately 25½ tons of timber. The principal dimensions of the bridge are given in the table.

Bridge Dimensions

Clear opening to dock	70ft
Span between centre line of trunnions	100ft
Length of moving span	69ft 11½in
Approximate overall length of bridge	198ft
Clear height under machinery portal	16ft
Angle of opening of bridge	87 deg.
Overall width of bridge	37ft 1in
Distance between centres of trusses of moving span	25ft

The maximum loads for which the bridge was designed are those specified in the B.S.S. 153, for the highway load 15 units plus 50 per cent impact, whilst the rail loads consist of a shunting locomotive of about 50 tons total weight, followed by a train of 16 tons axle loads, with 20 per cent impact allowance. The footways are rated at 84 lb per square foot. The bridge was designed to take two-way road traffic or one line of road vehicles plus one line of rail vehicles.

The plates and extruded sections for the bridge were supplied by the British Aluminium Company, Ltd., and the Northern Aluminium Company, Ltd. Two kinds of aluminium alloys were used. These heat-treated alloys are designated in the B.S.S. 1470 series, their principal properties being given in the table below.

Aluminium Alloy Details

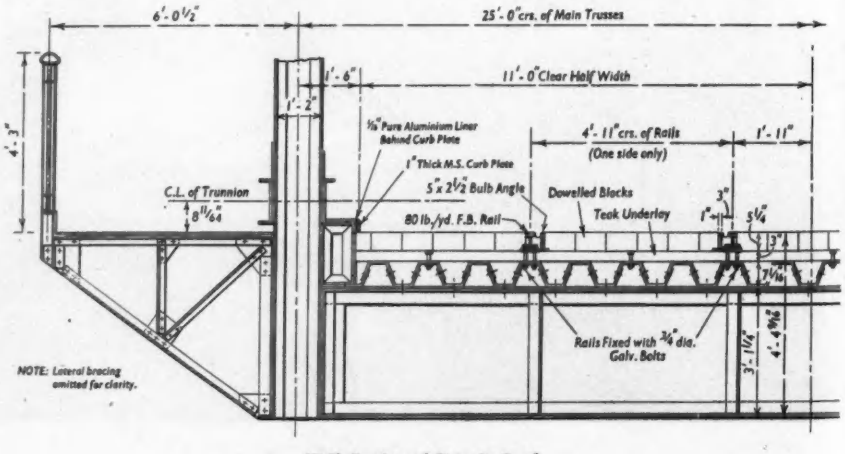
Alloy	0·1 per cent proof stress	Ultimate tensile strength	Per cent elongation (2in g.l.)	
	Tons/sq. in.	Tons/sq. in.		
HE10WP	15	18	10	Used for main trusses and machinery portal beam
HP10WP ...	14	18	8	
HE15W ...	15	25	15	Used for flooring system of bridge
HPC15W	20	26	8	

To ensure maximum protection against the acid bearing teak underlay, the whole of the flooring system was metal sprayed with 99·5 per cent pure aluminium. Throughout the fabrication and erection of the bridge precautions were taken to insulate all dissimilar metals to prevent any possible electrolytic action.

An advance in the technique of aluminium fabrication has been the successful cold driving of large-size aluminium alloy rivets up to ⅞in nominal diameter both in the shops and at site. The rivets have special heads—either recessed heads or "grommet" heads—to facilitate their driving. Rivet test pieces driven on the site were subsequently tested at the University of Aberdeen with satisfactory results.

Counterbalancing and Operating Machinery

The dead weight of each moving leaf is counterbalanced by the use of a fixed amount of counter-



Half Section of Bascule Leaf

* See THE ENGINEER, December 3, 1948, page 575.

weight contained in a welded steel box, hanging from a 1¾in diameter locked coil rope and passing over the cam, bolted to the main truss of the moving leaf. The cam provides the necessary variation in "lever arm" to the counterbalance pull, which is required as the moving leaf is being opened or closed. There are two counterbalance weights for each leaf, one on each side of the truss, and the counterbalance weights run into pits, at the rear of the mass concrete foundation, as the moving leaf opens. The shore steel fixed structure has an "A" frame at its rear which carries a 7ft 6in diameter pulley, over which the counterbalance weight rope passes. Each balance box weighs approximately 24 tons, the weight being made up of cast iron blocks bedded in lead.

All the operating machinery is neatly housed within the aluminium alloy portal girder some 5ft square, forming part of the moving leaf. The machinery, driving the bridge up and down, operates on the twin "Fluidrive" system. Two electric motors (13½ h.p. and 10 h.p.) running at different speeds, drive into a differential via fluid couplings, which permit the slower motor to be reversed when a "creeping" speed is required. This twin "Fluidrive" system is a recent development and enables the bridge to operate at a very fast speed of "creeping," in conjunction with electric control equipment. When the bridge is fully open the portal girder forms a further barrier to any road traffic which may have over-run the outer gates. The steel pin rack quadrant is embodied in the shore fixed structure, as the illustrations clearly show. The rack comprises seventy-eight pins positioned to a close tolerance and meshes with a pinion extending from the portal girder of the moving leaf.

The Steel Fixed Structures on the Shore

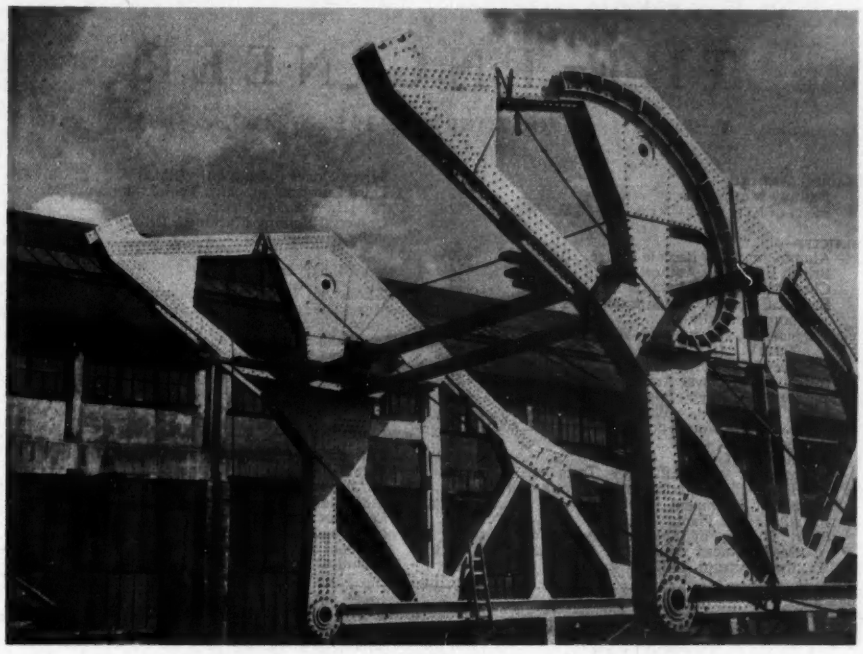
The steel fixed structure performs the dual function of carrying the counterbalance weight pulley and helping to transmit a portion of the live load on the moving bridge well away from the quay face. The live load is transferred from the moving span through "stop arms" on the trusses. A pit is provided in the foundations for the truss stop arm when the bridge is fully open, and the arm is shown resting on the stop in this position in our illustration. When the bridge is lowered the stop arm bears upwards on to a portal beam forming part of the fixed steel structure. This portal beam consists of two cast steel channels and is marked in the illustration; load is transferred to this portal beam when there is a live load on the bridge.

Electrical control equipment is installed so that the bridge is controlled by a master drum controller, operating relays, and beyond this everything is automatic. The bridge operator may control the bridge from the control house on the south approach or from a remote control panel on the other side of the dock entrance. Luminous indicators are provided which show all positions of the bridge, and navigation lights are fitted for both road and shipping traffic. Interlocks are provided to render the electrical operation foolproof.

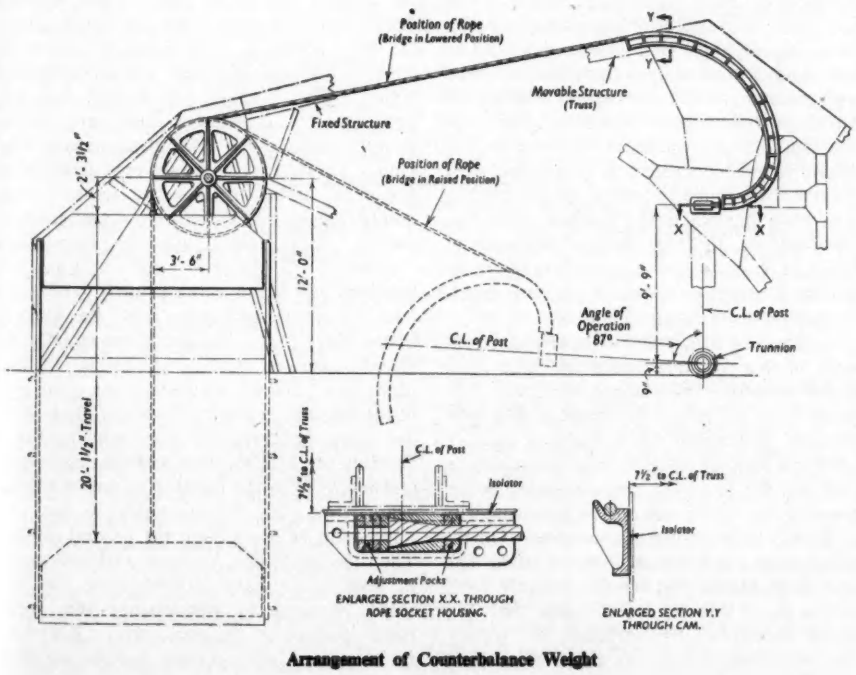
When in the down position the leaves are locked to each other by two steel bolts which ensure that the leaves deflect together as a load passes over the bridge. The bolts are driven by a motor through gears and are controlled from the master controller through a limit switch. The longitudinal camber in the movable bridge is 4½in between trunnions.

In the event of an electrical power supply failure, hand operation of the bridge may be carried out. Further, if one motor goes out of commission, it is possible to operate the bridge on one motor. Protective fencing is provided to prevent any entry to the various pits, &c., whilst flashing light and Klaxon horns give warning signals.

During erection of the bridge the shore steel fixed structure was positioned first and subsequently the moving spans were mated at site. A trial erection of the aluminium alloy moving spans at Thornaby enabled the flooring contractors to obtain the actual dimensions of the spans and prefabricated the wood decking. The lightness of the aluminium meant that large pieces could be shipped direct to site and heavy cranage was not required. A coaster, S.S. "Ardgantock," took the whole of the moving spans and two steel quadrants direct to Aberdeen from the erectors' wharf.



Shop Assembly of Aluminium Leaf Structure



Arrangement of Counterbalance Weight

Petroleum Equipment

The Council of British Manufacturers of Petroleum Equipment has recently published a pamphlet which is entitled "The Work of the Council." This body, formed by manufacturers of petroleum equipment, is concerned with the technical advancement of the equipment industry and its relations with the petroleum industry. According to the pamphlet, the Council, which became a company limited by guarantee in 1951, has not changed its object during the nine years of its existence. To-day, the Council has 375 members, and is recognised by Government departments as a body representative of concerns manufacturing items required for all activities from the winning of oil to its distribution. It is stated that close liaison is maintained at high level with parallel bodies, Government departments and the oil companies, and that members are kept informed of developments in the petroleum industry. The Council forms a common ground for the interchange of ideas and provides technical advice, the various technical subjects being matters for study by specialised sub-committees, while it is recorded that research is stimulated and standards established in association with the British Standards Institution. There is a technical adviser who sits on the various committees, and the Council sponsors a number of publications, including the *British Petroleum Equipment*, which is a biennial production, and a comprehensive classified list of products. Other publications mentioned in the pamphlet are *British Petroleum Equipment News*, issued quarterly and containing information on developments, and fortnightly circulars such as "Technical News Summary," "Council News and Notes," and "General News Summary," which are received by members only.

THE ENGINEER

Vol. 196 OCTOBER 2, 1953 No. 5097

LEADING ARTICLES—
Railway Motive Power Transition 432
Effect of New Weapons on Air and Sea Warfare 432

ARTICLES—
Aluminium Alloy Bascule Bridge. (Illus.) ... 429
British Electricity Authority 434
Chemical Research Laboratory 417
Electrical Manufacturing Extensions in Loughborough. (Illus.) 427
Engineering, Marine and Welding Exhibition. No. IV. (Illus.) 441
Engineers' Guild 417
Institution of Naval Architects. No. II 422
Jubilee of the Rugby Engineering Society 417
Large Boring Mill. (Illus.) 435
London-Chelmsford-Southend Railway Electrification 417
Maintenance Grader. (Illus.) 444
Performance and Efficiency Tests on S.R. Diesel-Electric Locomotive. No. I. (Illus.) 424
Petroleum Equipment 431
Rear Axle Test Plant. (Illus.) 440
Short History of Spectroscopy. No. IX: Measurement of Energy Distribution in the Spectrum. (Illus.) 418
Surrey Docks Substation. (Illus.) 438
Third European Machine Tool Exhibition. No. III. (Illus.) 419
Universal Folding Machine. (Illus.) 444
Volta River Project 417

LETTERS TO THE EDITOR—
"Britannia" Locomotives 433
More Thoughts on A.T.C. 433
Some Notes on Plane Frames not Obeying Hooke's Law 433

OBITUARY—
Percy Butler 433

NEWS AND NOTES—
British Patent Specifications. (Illus.) 447
Catalogues 448
Forthcoming Engagements 448
Industrial and Labour Notes 445
Launches and Trial Trips 448
Notes and Memoranda 446
Personal and Business 446
Technical Reports 440

RAILWAY MOTIVE POWER TRANSITION

The presidential address to the Institution of Locomotive Engineers has come to be regarded as one of the great occasions in the railway year. Since nationalisation, and the consequent steps towards a unified policy for motive power and rolling stock in Great Britain, the proceedings of the Institution have assumed a deeper significance, since it is no exaggeration to say that the eyes of the whole railway world are looking to Britain during these years of transition. In delivering his presidential address on Wednesday, September 23rd, Mr. R. C. Bond looked back over the thirty years of his own railway career; but rarely can a retrospect based on personal experience have contained so brilliant and dispassionate an analysis of changing conditions, or so clear an exposition of the case for each of the alternative forms of motive power. One could almost say that he put the major part of to-day's locomotive problem into a single sentence: when he joined the Midland Railway in 1920 coal of the finest quality was abundant and cheap, whereas to-day it is generally in short supply and the better qualities are not merely expensive, but often impossible to obtain. Yet with fuel oil at its present relatively high cost diesel-electric locomotives, despite their higher thermal efficiency, show no appreciable saving over coal-fired steam locomotives in fuel costs per unit of work at the drawbar, and in such economic conditions it is no more than logical to base plans for future British motive power largely upon the continued use of home-produced coal. Again, however, it is essential, on a long-term view, that such fuel be used in the most economical manner—that is, in a central power station—and the present trend in British railway motive power is turning towards the widespread extension of electrification. The gradual development of a policy in this direction is strengthened by the view that the most practical way to make use of atomic power for transport purposes will probably be through conversion to electricity.

It was very interesting to learn from Mr. Bond's address that designs for new standard main line electric locomotives are now being worked out by British Railways, and that prototypes are to be built and tested. Thus, when the large schemes under consideration come to be authorised well-tried locomotive designs will be available for quantity production. But although British Railways now seem to be turning towards electric traction for the future there is no suggestion that the abrupt and almost incredible end to steam locomotive development that has occurred in America is likely to be repeated here. Mr. Bond emphasised that for many years to come steam will provide the backbone of British railway motive power, and he told of the many ways in which the overall performance of steam locomotives is being improved. In so doing, he drew a very interesting comparison between the ways in which steam locomotives were used in America and in this country—a contrast in methods which he thought had been responsible for the sudden decision in America to make a wholesale change from steam to diesel-electric traction. With mechanical stokers locomotives were habitually run at very high rates of evaporation, resulting in boiler efficiencies of 50 per cent or less; this practice had an adverse effect upon boiler maintenance costs compared with the British method of working well within maximum capacity. The fact that the optimum efficiency of the British steam locomotive is maintained over a fairly wide range of power output renders it a more flexible traffic machine than the diesel-electric, the high thermal efficiency of which is confined to a considerably more restricted range, as shown in the test results we publish elsewhere in this issue.

In referring to steam locomotive development in this country during the years prior to the outbreak of the second world war, Mr. Bond was no doubt thinking of his own personal experience when he said that in 1923 the general level of coal consumption was 4·5 lb to 5 lb per drawbar horsepower hour. So it was on the great majority of British locomotives of that time. On the other hand, the Great Western then had several hundreds that would certainly come within the 3·0 lb to 3·5 lb range that Mr. Bond quoted as the standard for to-day. The development that has taken place since that time has not merely raised the general level of thermal efficiency. Improvements in workshop technique and organisation, and attention in design to details calculated to lessen shed duties and daily maintenance, have yielded good results in greater availability of locomotives and increased mileage between periodical repairs. In 1923, some 16 per cent of the total stock was awaiting repairs, whereas to-day the corresponding figure is 5 per cent. With the new "Britannia" class locomotives the average mileage between periodical repairs, so far, is 123,000, and Mr. Bond said that he had set a future target of 100,000 miles as the all-line average for British steam locomotives. Experience with unconventional designs, in various attempts to effect a large increase in thermal efficiency, had been disappointing—an experience wholly in line with similar experiments in other parts of the world. By way of contrast tests at Swindon and Rugby to increase the power output and general usefulness of the simplest and most straightforward types of steam locomotive are proceeding very successfully. Thus, while in the future electric, steam and diesel-electric locomotives will be used in the kind of service to which each is most suited, development of the oldest, as well as of the newest form of motive power is to continue unabated.

EFFECT OF NEW WEAPONS ON AIR AND SEA WARFARE

Forthcoming tests in Australia are expected to provide valuable data on the efficiency and destructive power of various kinds of new missiles and the results may well determine the kind of armaments likely to be required in the coming years. They will be of particular importance for this country because her sea power has usually enabled her to employ new weapons and material to the best advantage. It is thus very desirable that the Prime Minister or the Minister of Defence, should take an early opportunity of giving the nation an appreciation in broad terms of the effect which guided missiles and atomic weapons will have on the conduct of war in the air and at sea. There is all the more need for this in view of the apparent contradiction between officially inspired statements and Government policy. The Minister of Supply recently expressed his confidence that no piloted aircraft could hope to out-manœuvre the kind of guided rockets we are now developing and that guided missiles for artillery and bombardment would follow the anti-aircraft rocket. Why, then, are the long-range "Victor," "Valiant" and "Vulcan" bombers still given super-priority? Moreover, it seems surprising that the United States Navy is still building giant 60,000-ton aircraft carriers, costing some £78,000,000 each, to enable medium-range, carrier-borne aircraft to carry out strategical bombing from positions off an enemy's coast. Possibly the Minister was anticipating events and referring to the position in ten or fifteen years' time, but this certainly is not the impression he has left on the general public. The time factor has, however, little relevance in relation to naval construction, for the ships required in commission ten years hence should be designed now. Are they to be armed with guided rockets in place

of strike aircraft or large shells ? Rockets with sufficient destructive power extensively to damage a heavy ship must be large missiles—probably similar in size to the German "V 2." If the missiles successfully tested in the United States are to be regarded as prototypes, they will have a length of some 48ft and weigh 5½ tons, in which case battleships will be required not only to carry a worthwhile number, but also to have the armour needed as protection against them. Is it, then, reasonable to forecast from developments now in progress that naval actions may be fought between heavy ships at ranges of 200 miles, as in the Pacific war, but with rockets—guided by an aircraft overhead at the height required to give the radar horizon—in place of strike aircraft ?

There would seem little purpose, however, in considering the use of the large guided missile for artillery or bombardment without relation to atomic explosives. An 11in atomic shell-firing gun has now been developed for the United States Army—indeed, six of these guns are shortly to be sent to Europe to strengthen the N.A.T.O. defences. Whatever its merits as a tactical weapon in the field, this 11in shell is a clear indication that atomic explosives can be used in other types of large conventional missiles, such as the warhead of a large rocket. The critical size of a mass of fissile material, beyond which an explosion occurs, is constant and of small dimensions, but hitherto the mechanism or other means employed to produce an explosion has required a very large aircraft to carry it. If, therefore, the piloted bomber, releasing its bombs overhead, is to be rendered innocuous by the anti-aircraft guided missile, it may be assumed that the large guided rocket with an atomic warhead will replace it as the explosive carrier for strategic bombardment. In that event, unless the rocket is made so large that it becomes itself a target for the anti-aircraft missile, fuel considerations are likely to limit the range to about 500 miles. The guided bombardment missile would appear, in fact, to be a substitute for the medium-range bomber which the United States Navy has in mind to operate from giant carriers, entailing a new use for the battleship in the role of a strategic bombardment vessel. On the other hand, a long-range bomber or a submarine could each carry one of these large rockets, or other type of large guided missile, and launch and guide it from positions 200 miles from British territory. Our potential enemies may well find this the most effective way of employing their large forces of bombers and submarines.

Fissile material is in short supply and is still difficult and costly to produce. It is thus unlikely to be used except against very valuable targets or targets covering a wide area in which the full effect of its enormous destructive power will be felt. This, again, may mean that battleships will have to be armed also with artillery rockets fitted with non-atomic warheads for ship actions at sea, depending on whether a potential enemy builds vessels of similar type with the intention of fighting for the control of the sea communications. In the absence of official guidance, one can do no more than speculate on all these questions which are of the greatest interest to the public at large. Secret information cannot and should not be divulged, but the kind of warfare which may be anticipated as the result of recent developments must be known to atomic scientists and armament experts of all nations and should, in our view, form the subject of a Government statement.

Obituary

PERCY BUTLER

As recorded briefly in our last issue, the death of Mr. Percy Butler occurred at his home in Edinburgh on September 21st. He was a director and joint general manager of Bruce Peebles and Co., Ltd., which company he joined in 1926.

Mr. Butler was born at Normanton, Yorkshire, in 1896, and was educated at Normanton Grammar School and Leeds University. He obtained practical experience as an engineer with Rhodes and Co., Ltd., and, following active service in the first world war, he returned to Leeds University, where he took his B.Sc. degree. Mr. Butler then joined the transformer design staff of Metropolitan-Vickers Electrical Company, Ltd., at Trafford Park. He was appointed senior transformer designer to Bruce Peebles and Co., Ltd., in 1926, and was promoted to the position of manager of the transformer and rectifier departments in 1943. Last year, Mr. Butler became joint general manager of Bruce Peebles and Co., Ltd., and was elected to the board.

Mr. Butler took a keen interest in all matters concerned with the profession of electrical engineering. He was elected to full membership of the Institution of Electrical Engineers in 1944, and was chairman of the Scottish centre in 1951–52. Mr. Butler was also a past-president of the Edinburgh Electrical Society and chairman of the Edinburgh Industrial Air Raid Precautions Association.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

MORE THOUGHTS ON A.T.C.

SIR,—Your leader on this subject emphasises that the multiple-aspect colour-light signal introduces further complication into any automatic train control system if it be demanded that each aspect must be distinctively indicated in the cab. On the other hand, and especially in view of the cost of the colour-light signal, would it not be reasonable to cash in on its really valuable feature, which is the certainty of being seen even in the foggiest weather, provided only that the driver is looking ahead just before he reaches it?

All safety requirements are met in the simplest possible manner by A.T.C. that on the approach to every distant signal, regardless of aspect, sounds an alarm and begins to apply the brakes until overruled by the driver when he sees a "clear" signal. The worst that could happen would be unnecessary delay to the train if the driver missed a "clear" signal, a negligible chance if it is of the colour-light type and he has been told just when to start looking.

If the fixed signal is of a type that may be invisible in thick fog, there is a case for repeating its aspect in the cab, but now that the colour-light signal is well established and its use, at least as a distant signal, is likely to be extended in any case, the only necessity is to remind the driver to look out at the right time and to stop the train if he fails to acknowledge the reminder This can be done by inexpensive mechanism without magnetism or electricity and with no apparatus, except a cancelling handle, in the cab.

Cab duplication of every aspect of fixed signals is technically possible if expense is no object, but its desirability is debatable inasmuch as it may persuade a driver that he need not look out at all until the apparatus signals "caution" ; in other words, it encourages a carefree attitude that could never be officially approved. This is an unsatisfactory by-product in return for an expenditure of £17,000,000 plus £1,000,000 per annum in maintenance.

W. A. TUPLIN
Professor of Applied Mechanics
University of Sheffield,
September 12th.

SOME NOTES ON PLANE FRAMES NOT OBEYING HOOKE'S LAW

SIR,—Mr. Charlton seems determined to misunderstand my article.

In my first paragraph, item 3 states quite definitely that Castigliano's theorems normally do not hold for frames with non-linear stress strain characteristics.

The portion quoted by Mr. Charlton certainly states that one of the easiest proofs of Castigliano begins by using $\Delta = \Sigma \delta \, . \, \partial P / \partial W$, but then goes on to say that it was unfortunately misused mathematically to become the familiar Castigliano's Theorem as defined. It does not state that the formula is Castigliano's Theorem. It is in fact a geometrical relationship applicable to both linear and non-linear frames alike, which only becomes Castigliano's Theorem after the mathematical misuse indicated in paragraph 4, which puts it in the familiar form applicable only to linear structures.

I agree that a solution of a structure with six redundancies would be laborious—it would be so even for a linear structure, by any method, and the added complication of non-linear characteristics would certainly not simplify it. Nevertheless, the method will solve such a structure, and the simultaneous equations may be circumvented by a modified relaxation or successive approximation technique if desired, just as they are in the case of linear frames. I think it would be rather more constructive if Mr. Charlton would show us a quicker method of dealing with my much simpler Problem 3 instead of asking me to solve a long-winded problem involving masses of figures of interest to no-one.

J. W. H. KING
Mile End Road, E.1, August 27th.

THE "BRITANNIA" LOCOMOTIVES

SIR,—I did not see Mr. Gwyer's second letter until a week after it had appeared in your columns, as I had been away from home ; but I do not think it necessary to comment upon the flights of fancy contained in his first paragraph.

As to the "Britannia" locomotives in East Anglia, the "B12" 4–6–0s of the former Great Eastern Railway were displaced from the more important duties upwards of twenty-five years ago, when the Gresley three-cylinder "B17" class was introduced. I know that "B12" engines, and particularly those rebuilt with larger boilers and long-travel valves, continued to do high-class work on occasions ; but they were no longer the first-line express engines. The "B17" class in their turn came to be displaced, from 1946 onwards, by the Thompson "B1" class and it is these latter that have now given place to the "Britannias" on passenger work. But the "Britannias" also include in their regular diagrams a number of braked goods trains, on which they have replaced the "K3" class of three-cylinder 2–6–0.

If comparison is to be made on the basis of weight, then one should also include the weight of the tender, since the utilisation of the locomotive in a long-mileage diagram might well depend upon the coal and water capacity of the tenders. In this comparison the respective weights of engine and tender in working order are : "B1" class 4–6–0, 123 tons ; "K3" class 2–6–0, 123 tons ; "Britannia," 143 tons.

O. S. NOCK
Bath, September 8th.

British Electricity Authority

THE fifth annual report and statement of accounts of the British Electricity Authority for the year ended March 31, 1953, was presented to the Minister of Fuel and Power on Tuesday, September 29th.

The report shows that the Central Authority had a surplus of £5,824,452, compared with £4,251,640 in 1951–52, and the aggregate surplus of the fourteen Area Boards was £1,456,371, as compared with a deficit of £1,332,803 in 1951–52. These improved results were mainly due, in the case of the Central Authority, to the increase of 3s. per kilowatt in the maximum demand charge in the bulk supply tariff for supplies of electricity to the Area Boards and, in the case of the Area Boards, mainly to retail tariff increases made within the last two years, the earlier of which only became fully effective in 1952–53.

The financial results of the Authority and individual Boards for the year and (in brackets) the balances carried forward after taking into account the balances brought forward from 1951–52 and transfers to and from reserves were as tabulated herewith.

	£	£
British Electricity Authority ...	5,824,452	(2,029,289)
Area Boards :		
London...	1,465,407	(2,111,955)
South Eastern	175,402	(210,297)
Southern	106,331	(330,344)
South Western	−148,967	(−318,301)
Eastern	−411,992	(−109,240)
East Midlands	−310,923	(14,375)
Midlands	−641,603	(−376,714)
South Wales...	356,345	(606,104)
Merseyside and North Wales	196,667	(231,039)
Yorkshire	−113,299	(161,004)
North Eastern	33,737	(80,054)
North Western	671,399	(647,407)
South East Scotland	178,750	(69,790)
South West Scotland	−100,883	(−116,342)
Total	7,280,823	(5,571,058)

A brief summary of the year's operations is given in the following abstracts from the report.

Plant Installation.—At March 31, 1953, the Central Authority owned 285 power stations with a total installed generating capacity of nearly 17,157MW and a total output capacity, assuming all plant in service, of 15,535MW.

More than two-fifths of the generating sets and boilers in the steam power stations, representing over 15 per cent of the total generating capacity and 13 per cent of the total steaming capacity of those stations are over twenty-five years old.

New plant brought into service in 1952–53 gave an additional output capacity of 1423MW. Taking into account the removal of some old plant to make room for new or because it had become unserviceable or obsolete, and the revision of some plant ratings, the net increase in output capacity was 1321MW.

Some of the new plant was installed in seven new power stations which were brought into partial operation during the year as follows :—

	MW (sent out)
Bankside B (London)	56
Barking C	42
Brighton B	98
Huncoat (Accrington)	56
Keadby (Scunthorpe)	112
Littlebrook C (Dartford)...	56
Uskmouth A (Newport, Mon)	56
	476

Over 61,600 million units of electricity were generated by the power stations during 1952–53, which was 4 per cent more than in the previous year, 47·3 per cent more than in the year before nationalisation and two and a half times as much as the comparable production in 1938–39.

Thermal Efficiency.—The overall thermal efficiency of the Authority's steam power stations has risen steadily from 20·87 per cent in the pre-vesting year, 1947–48, to 22·04 per cent in 1951–52 and 22·72 per cent in 1952–53. In 1952–53 it took an average of 1·384 lb of coal to produce a unit of electricity (sent out), compared with 1·417 lb in the previous year.

The average delivered cost per ton of fuel consumed in the Authority's power stations was over 5 per cent higher than in the previous year. Average works costs per unit of electricity sent out from the steam stations, however, increased by only 2·6 per cent from 0·5309d. in 1951–52 to 0·5446d. in 1952–53.

The Authority continued to be the largest individual purchaser of coal in Great Britain. Fuel consumed in its power stations during 1952–53 amounted to nearly 35,750,000 tons, of which a little over 34,750,000 tons was coal. The total fuel consumption was 1·7 per cent more than in 1951–52. The difference between this percentage increase and the corresponding increase of 4 per cent in electricity generated reflects the improvements in efficiency.

Operations.—Operation of the grid system continued to be difficult during the year despite the record amount of new generating plant installed and the slackening in the rate of increase of demand. The number of occasions, however, on which it was necessary to cut off supplies to consumers was only nine, compared with seventy-nine in 1951–52. In the summer months (April to September) short interruptions of supply to a few consumers occurred on only three occasions, compared with seventy-three in the previous summer. In each winter (October to March) disconnections were necessary on only six occasions.

The maximum potential demand on the system occurred on Monday, December 15, 1952, and amounted to 14,850MW, compared with 13,535MW in the previous winter. The demand actually supplied by the plant available at the time was 13,301MW, as compared with 12,344MW in the previous winter, the differences between the two sets of figures representing the estimated amounts by which the loads were reduced by low frequency, reduction of voltage and disconnection of supply.

Supergrid in Operation.—The grid system of main transmission lines owned and operated by the Central Authority comprised at March 31, 1953, 4682 route-miles, of which 4174 operated at 132kV and the remainder at 66kV or lower voltages. The major grid development work put in hand during the year included 203 route-miles of 132kV lines and a further 372 route-miles of the new 275kV grid, of which the first section, comprising 41 route-miles of single-circuit line between Staythorpe (Newark) and West Melton (Sheffield), was in operation during the year at 132kV. [Operation of this line at 275kV began in July, 1953.]

Reinforcements of the grid system required to meet the growing load and to ensure reliability of supplies to consumers included arrangements for twelve more new points of supply to Area Boards' networks. It is estimated that, with these supply points, there will be a total saving of approximately £1,700,000, compared with the costs which would have been incurred if requirements had been met by developing existing points of supply.

Electricity Consumption.—At March 31, 1953, the number of electricity consumers exceeded 13,884,000, representing increases of 435,000 in the year, 2,170,000 in the five years since vesting day and nearly 4,000,000 since 1939. During the year new supplies were given to 10,584 farms, bringing the total number of farms connected at March 31, 1953, to 134,429, of which 48,874 have been connected since vesting day.

Consumers purchased 52,250 million units of electricity in 1952–53—3·7 per cent more than in the previous year. Roughly half the sales were to industry, a third to domestic consumers and an eighth to commercial consumers. Industrial consumption was 2·5 per cent more than in the previous year, domestic 1·7 per cent, public lighting 9·0 per cent, commercial 11·8 per cent, and farms 18·2 per cent.

The average price received for electricity sold for all purposes was 1·311d. per unit. This was 7·5 per cent above the 1951–52 average, 15·7 per cent above the average of 1947–48 and 24·9 per cent above that of 1938–39. The average price received for supplies to domestic users was 1·452d. per unit, compared with 1·353d. in the previous year. For supplies to industry the average price received was 1·088d. per unit, compared with 1·002d. in 1951–52 ; to farms 1·397d., compared with 1·339d.; to commerce 1·829d., compared with 1·760d.; for traction 1·016d., compared with 0·977d.; and for public lighting 1·337d., compared with 1·269d.

Future Developments.—Previous reports have referred to B.E.A. estimates of the increasing rates at which new plant will be required in the future. The following table indicates the annual amounts which would be brought into operation as a result of its plant programmes to the end of 1957 :—

Calendar year	Output capacity MW (sent out)
1953	1300–1500
1954	1400–1600
1955	1500–1700
1956	1600–1800
1957	1700–1900

For each year the lower amount is that which may be expected with confidence, and the higher amount that which may be possible, if nothing untoward affects existing plans.

The Authority also prepared in 1951–52 a provisional programme for 1958 and a tentative programme for 1959, each of 1900MW. In its fourth report, however, the Authority expressed concern at Government proposals, for economic reasons, to limit to 1550MW (sent out) the amount of new plant to be brought into commission in any one year. The Government had approved a scale of construction rising to this figure in 1955, and, in the year under review, they decided that this limit should apply also in 1956 and 1957. Subsequently, the Government decided that the limit for 1958 and 1959 should be 1750MW, the amount for 1959 being subject to review, and the Authority has taken steps to adjust its programmes accordingly. The permitted increases of plant are therefore as follows :

Calendar year	MW (sent out)
1953	1350
1954	1450
1955	1550
1956	1550
1957	1550
1958	1750
1959	1750*

* Subject to review

Because of the need to encourage and expand exports of capital goods the Government also decided in January, 1953, that export orders for power station plant should have priority over orders by the Authority in respect of their programmes up to 1959. Representations were made to the Government that the decision was likely to have serious effects on the progress and fulfilment of the programmes, and since the end of the year discussions have been proceeding on means of facilitating export orders without prejudicing delivery of the Authority's plant in accordance with the reduced programmes.

New Power Stations.—Power station capital contracts approved by the Authority during the year amounted to £96,000,000, as compared with £89,000,000 in 1951–52 and £85,000,000 in 1950–51.

At March 31, 1953, there were thirty-four new power stations and fifty-two extensions of power stations, with an aggregate installed capacity of some 9,440MW, under construction or planned in the Authority's construction programmes to the end of 1957. In addition, the 1958 programme, adopted during the year, comprises six new power stations and extensions to seven stations started since the war. [The six new stations in this programme are Kincardine (Fifeshire), Bold B (St. Helens), Skelton Grange B (Leeds), Elland (Yorks), Rugeley (Staffs), and Little Barford B (near St. Neots).]

120MW Generating Sets.—The bulk of the plant in current programmes consists of "standard" 30MW and 60MW turbo-generator sets, with steam conditions respectively of 600 lb per square inch and 850 deg. Fah. and 900 lb and 900 deg. at the turbine stop valve. New plant with higher steam conditions on which firm design work was started during the year includes that intended for the Willington A station near Derby, which will employ a 1500 lb, 1050 deg. Fah. "straight" cycle utilising 100MW sets, and that intended for two new stations, Blyth and Drakelow B (Burton-on-Trent), which will utilise 120MW sets on the reheat cycle, with steam at 1500 lb, 1000 deg. Fah., reheating to 1000 deg. Each turbo-alternator set will be supplied by a single boiler, which, in the case of Blyth and Drakelow B, will be rated at 860,000 lb of steam per hour.

It was decided, during the year, to construct a second semi-outdoor power station with boilers and associated plant completely unhoused, as at Ince, but with a different layout.

A Large Boring Mill

An interesting boring mill of particularly large capacity has been installed at the Rugby works of the British Thomson-Houston Company, Ltd., for the manufacture of parts for heavy electrical plant. The machine is designed to accommodate work 42ft 6in diameter by 14ft 6in high and its 25ft diameter table takes parts weighing some 120 tons.

IN the machining of the very large and heavy parts for modern electrical machinery it is very desirable to carry out as many operations as possible at one setting on a single machine in order to reduce the complications and time lost in transferring and resetting large units on successive machines. These considerations applied particularly when the machine tool equipment for the heavy plant building at the Rugby works of the British Thomson-Houston Company, Ltd., was being selected. Conventional boring mills were found to have certain limitations and the firm decided to develop a mill which would be adaptable for a very wide variety of duties and suitable not only for the largest sizes of work at present handled but also for the even larger and heavier work envisaged in the future. Such a machine was designed and built and was put into service early this year. In developing the machine the company's engineers had the co-operation of a number of firms in the British machine tool industry in solving many of the technical and manufacturing problems. The new machine can be seen in the accompanying photographs and drawings.

The machine has a revolving table 25ft in diameter suitable for accommodating work-pieces up to 42ft 6in diameter, 14ft 6in high and weighing 120 tons. It is anticipated that by special arrangement it will be possible to handle work of 65ft diameter if necessary.

The structure of the machine above shop floor level is sectionalised and the sections can be rearranged in various positions or entirely removed to leave the machine table and surrounding floor rails and bedplates available for general shop purposes.

A 25ft diameter table supplied by George Richards and Co., Ltd., which forms the centre of the machine has the standard under-structure modified for in-line drive from a B.T.H. 110 h.p., 500V d.c. reversible motor with 3 to 1 speed range, through a six-speed gearbox.

This gearbox is fitted on electrically-operated gear change mechanism and the range of table speeds available is from 0·16 to 5·02 r.p.m. Both the motor and gearbox are mounted in a side annex, opening off the main centre well of the foundations, and covered over with removable cast iron floor-plates which form, on their upper surface, part of the machine floor around the table. By means of a hand-turning shaft, acting through the gearbox, the table can be rotated to any angular setting observed through a sight glass set in the floor-plate conveniently adjacent to the operating position. The table can also be inched round under power by using a push button on a trailing lead, plugged into a point provided on the main control cubicle. Set in a groove machined round the periphery of the table and near the lower skirt edge, there is a steel-strip tape marked off in 360 principal divisions to present a fully graduated periphery. Sub-divisions of degrees are marked and the tape can be brought around to a zero position independently of table movement and then locked to the table to enable it to be used as a large dividing plate. An optical sighting equipment supplied by Optical Measuring Tools, Ltd., which is suspended below the floor plates and sights on to the tape, reflects on to a graduated vernier scale below the sight glass in the floor plate. This scale is adjustable to compensate readily for slight errors in the tape scale setting when locking to the table.

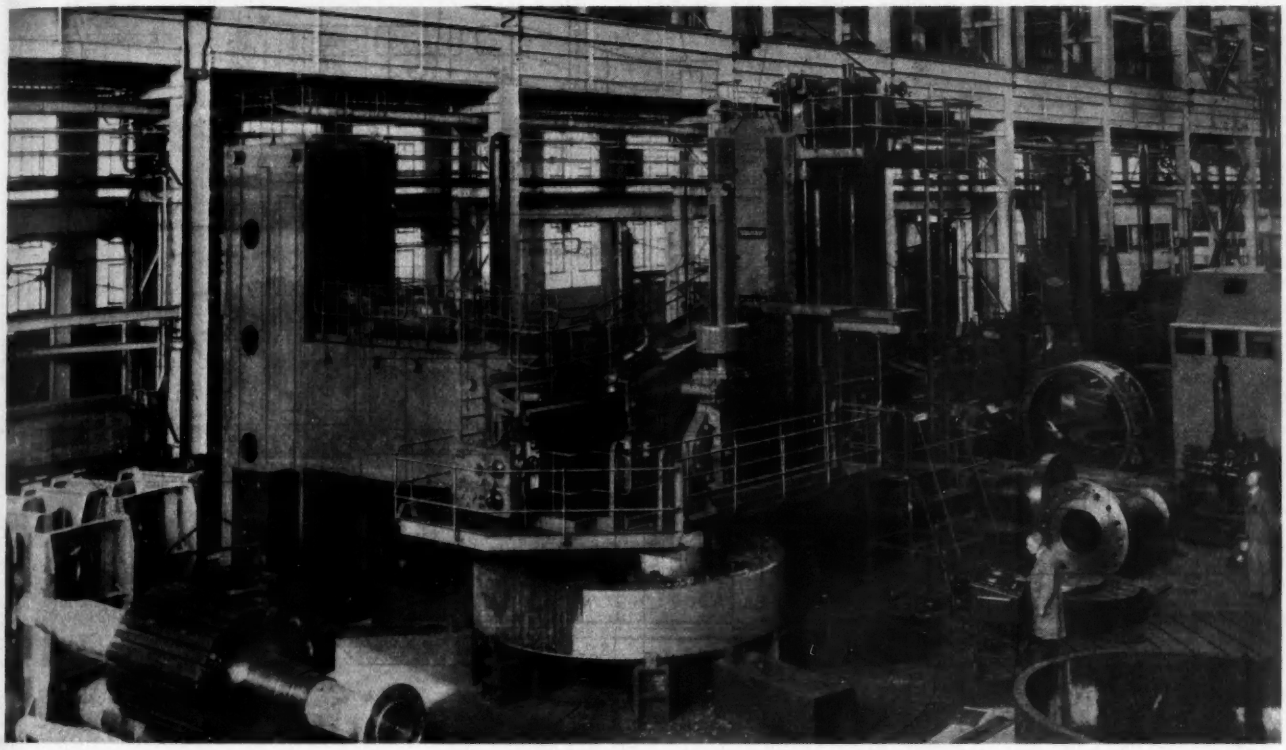
In order to prevent undue rotation of the table when engaged on indexing, two Ferodo-lined brake blocks 180 deg. apart can be brought to bear on the table skirt. The brakes are applied by a wedge action behind the shoes, movement being initiated by a hand-pump operated Lockheed hydraulic system. The table drive is electrically interlocked to prevent operation when either the hand gear, or the brake shoes are engaged, or the various lubricating oil systems are not functioning correctly.

A top bearing is formed by the centre stalk of the main table for a separate central drive shaft which terminates in a large flange-end slightly below the table surface level. A series of tapped holes and a large driving slot across the upper surface of this flange are used to secure and drive a central boring bar, respectively.

The centre drive shaft extends down into a foundation well to an independently driven gearbox which is used for the boring bar drive. This gearbox, which has six mechanical gear changes and is driven from a B.T.H. 30 h.p., 500V d.c., 2/1 speed-ratio motor, gives a boring bar speed range from 0·67 to 29 r.p.m. The boring bar drive unit is designed to carry a vertical load of 60 tons and is mounted on a bed-plate built into the bottom of the main foundations. Underneath this bed-plate is the main sump.

Rotation speeds of the main table and boring bar drives are indicated in both forward and reverse directions on two large 30in diameter etched glass indicator dials made by the Record Electrical Company, suspended side by side under a projecting gantry of the shop gallery. Transmission of speed readings is by electrical means from B.T.H. tacho-generators directly geared to the table and to the boring bar drive shaft.

The main well of the machine foundation is extended outwards to a deep annex opposite the shallower annex for the main table drive gear, covered over by removable floor-plates. This arrangement facilitates withdrawal of the boring bar drive gear for maintenance purposes and, by means of a side access passage, forms a convenient access to the foundations. Side galleries in the main foundations open on to the well portion and provide access for levelling the main table under structure, for cleaning out under a 15in wide removable chequer plate



Boring Mill in Operation

surround to the table, and between the table periphery and the surrounding floor. The foundations also provide accommodation for small auxiliaries, including oil return tanks and pump equipment associated with the table lubrication system.

The work involved in the extensive foundations can be appreciated when it is pointed out that the centre-well floor is 12ft 6in below shop floor level, and the distance between the outer ends of the annexes to the well is 63ft. It is estimated that the foundations and surrounding floor rails and bed-plates associated with this machine weigh some 620 tons and the machine parts below floor level carried by the foundations weigh some 200 tons.

Let into the surface of the machine table are covered openings giving access to electrical sockets mounted under the table and connected to 440V, three-phase, 50 cycle a.c. slip-rings on the under side of the table casting. By this arrangement a supply of electric power is made available on the table surface, with the table either rotating or stationary. A plug point of 100A capacity for heavy power requirements on the table is used in conjunction with the multi-point splitter pillar unit shown in one of the accompanying illustrations. This pillar unit can be plugged to the table point and bolted in a convenient position for switched supplies to be taken from the plugs on the pillar which have 15A, 30A, 60A and 100A ratings. This installation of a mobile table power supply is in anticipation of the possible mounting on the table of portable machine tool units or even welding sets. Other plug points in the table surface are connected to give 50V supply by means of 440/50V "Lo-volt" lighting sets. There are also three plug points for the "emergency stop" circuit and the "emergency stop" control is fitted on a trailing lead when in use to enable an operator on the table to stop the whole machine.

The boring bar for mounting on the centre drive is some 22ft 3in high and its bottom end is enlarged to form a gearbox giving high, low and neutral running positions. The body of the bar has two slots, in one of which is a vertical traverse screw, and in the other a keywayed shaft for cross traverse drive take-off. A Mechanite sleeve which is keyed to the bar and is driven by the two slots has its outer surface machined to receive boring tools and short boring tool holders. On the traverse shaft side of the sleeve a take-off with bevel gears is arranged for radial traverse drive. This sleeve is accurately machined to form a centre mounting for split-mounted balanced boring heads used for boring larger diameters from some 27in up to about 14ft.

The range of boring bar speeds available coupled with differential running with the table, enables rotating work to be machined on its larger diameters, and at the same time bored on smaller diameters, at a useful machining speed. The boring bar gearbox is star-wheel driven from a series of retractable strikers held in a special mounting plate fixed to the centre of the main table. This arrangement makes available differential speeds of bar and table, and reversing of the drive is effected by changing over the star-wheel to the opposite side of the gearbox. Independent operation can be effected by hand or power drive to a shaft in a recess at the side of the gearbox. The bar traverse speed can be varied in either of the two ranges provided by the gearbox and also by bringing into use a differing number of the striker arms, of which twelve are provided.

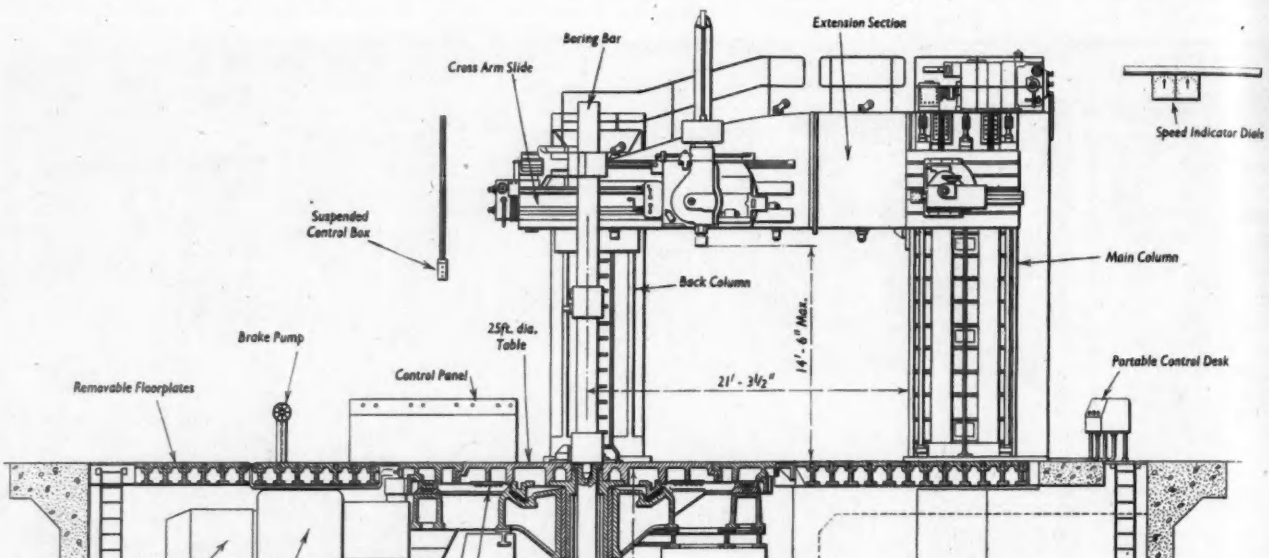
Mounted on the bar above the sleeve is a spherically seated split-bearing bush rotating on a steel sleeve keyed to the bar—but free to move in an axial direction on it. On the upper surface of this bearing is mounted an automatic Wakefield lubricator for supplying the bearing with oil. A housing with spherical seating to receive the bearing shell is attached to the face of the main cross-arm, along which it is screw-operated for a limited distance. The housing also incorporates an inclined slide-face, the combination of the two movements along the arm and on the inclined slide enabling the housing to be accurately centred around the bearing on the bar. The boring bar can thus, in effect, be fitted with an outboard bearing on the superstructure of the machine to assist in its rigidity and true running.

As previously mentioned, the superstructure of the machine can be entirely removed. It is composed of four major elements, the relative positions of which can be varied considerably and consist of the main column, the back column, the main cross-slide, and the back cantilever arm. The whole of the superstructure weighs about 155 tons.

The main column of welded steel plate construction, is bolted to a heavy floor-plate at the right-hand side of the machine and can be set in relation to the edge of the table to suit working requirements. The column is 22ft 3in high and at its base is 9ft 6in by 6ft 9in. Heavy slideways up the front and rear faces of the column comprise assemblies of chilled cast iron sections and on the side of the column nearest the table are two machined and tapped steel facings. These facings are also drilled and reamed for dowels, both the dowel and the tapped holes being at regular pitches in co-ordinate dimensions. The far side of the column incorporates a series of recesses to accommodate the electric control gear. A Richards horizontal boring machine table fitted with a side-head tool ram is mounted on the vertical ways up the front of the column. A hand-wheel adjustment of the ram is used for radial positioning but its vertical and cross power traverse movements are applied through the table mechanism. The ram power cross traverse is transmitted through a vertical shaft set between the main ways, whilst its vertical traverse is through two lead-screws outside the ways. These traverse shafts are coupled to mating extension shafts projecting downwards from a gearbox drive mounted on the top of the column.

As the position of the column is adjustable on the floor it was not possible to adopt the conventional method of mechanical interconnection with the main table when designing the machine. Moreover, it was envisaged that the column alone could, if necessary, be used as a portable machine tool unit. For this reason a B.T.H. "Emotrol" (electronic motor control) system, receiving its reference voltage from a tacho-generator directly-driven from the main table gear and operating through a control panel, was developed and incorporated. This arrangement is designed to ensure that, when the circuit is closed, the motor driving and traverse gearbox on the top of the column has its speed synchronised with the table speed. The motor drive is connected to a Richards feed gearbox and thence to the special transmission box for taking the drive to the vertical feed shafts. This gearbox gives the necessary feed speed changes and it is also fitted with an independent motor for fast traverse purposes. The whole system of traverse drive equipment, with the exception of the control panel, is mounted on a heavy fabricated base-plate covering one-half of the area of the top of the column.

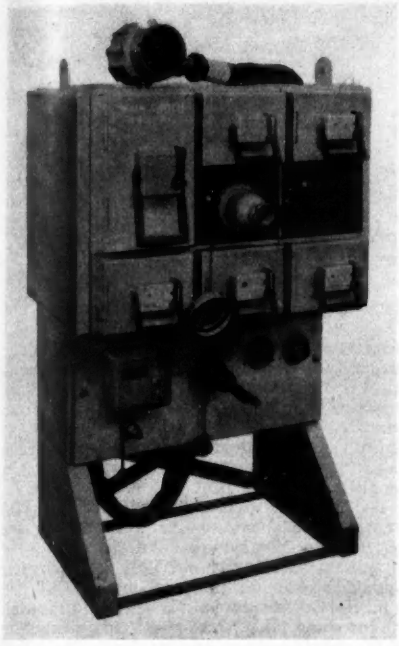
Also contained in this top unit is a motor-driven lubricating oil pump which is fitted with a pressure switch to ensure that the oil circuit is effective before the motor drive can operate,



Arrangement of Boring Mill

and as a protection against oil pressure failure.

On the side of the column remote from the machine table are housed the main switchgear, control panel, and sub-circuit switches for power supply and distribution to the column, and also the circuits to the main cross-slide. Leading to the column is a trailing cable having a heavy supply plug, with control circuit contacts which are plugged into an adjacent socket set in a sunken box in the floor. In view of possible use of the column as a portable tool special power arrangements were incorporated. When the heavy current plug is connected to a normal 440V, three-phase, 50 c/s supply, the "Emotrol" motor runs at a constant speed governed by the supply frequency. This speed is so



Multi-Point Splitter Pillar Unit

arranged that the mechanical speed ranges as depicted on the various feed dials are accurately obtained.

The front table is also arranged for the mounting of a complete horizontal boring-head unit suitable for a wide range of work by reason of the range of vertical height and cross-table movements.

The slides at the back of the column can be used with a similar table to that at the front side. When fitted this table would be raised and lowered on screws having a much coarser pitch than are used at the front. Fitted with a knee tool-bar holder, the table would be suitable for use in heavy vertical face slotting or planing work.

The free half of the top area of the column is reserved for another gearbox drive and there is room in the control cupboard for its extra gear. Recessed in the face of the column, between the faces prepared for receiving the cross-slide cantilever arm, are multi-point sockets at various heights.

Control of the front table traverse speeds is effected from the top access gallery and certain of the master controls are also available on the table platform.

The cast iron box-section main cross-slide is heavily ribbed, and flanged at one end to mate to the main column. The under-side is flat and horizontal, the upper surface being parabolic. At the front are integral ways and an upper "T" slot slide to receive a Richards sliding-head unit and at the outboard end, facings are fitted to mount a feed gearbox unit. Also at the front are slide faces to accommodate the bearing housing for use with the centre boring bar. The back face of the arm has a machined centre channel and facings parallel to the front ways.

Housed inside the arm is a B.T.H. geared motor unit and connecting shaft to the feed gearbox; a control panel for the "Emotrol" equipment, and a "Wayne" cable reel, from which power supplies may be fed through the front of the arm to the tool slide.

Speed control is similar to but independent of, that for the front table movement of the main column and here, again, connection to a normal a.c. supply can be used when it is desired to use traverse movements independently of the main table movement. The main saddle carries a sub-slide which can be inclined to the horizontal at any angle up to plus or minus 15 deg. This sub-slide has powered movements and for short surface work, within its compass, can be levelled and used without the main arm being levelled.

By close collaboration with, and between, Kendall and Gent, Ltd., and George Richards and Co., Ltd., the facing on the sub-slide was designed to take, in addition to the standard tool ram banjo mounting, a Kendall and Gent 20 h.p. powered vertical milling head, with a hand-operated vertical feed of 10in and integral control equipment. The normal inclination to the vertical obtainable on the tool ram can also be obtained on the milling head and the milling head assembly is supplied with power via the cable from the cable reel housed in the arm.

When positioning the arm to the main column a heavy bearing plate is first mounted and bolted to the main column facings. This bearing plate has two substantial dowels which engage with holes in the main column facings and, after being assembled at the selected height position, the plate is bolted up to the column. When the machined bottom edge of the arm flange is then rested on the upper edge of the bearing plate the holes in its flange are correctly disposed in relation to the tapped holes in the main column surface, the clearance provided ensuring that the securing bolts can be readily passed through and screwed up.

In cases where work is exceptionally large, rotatable and necessitating centre as well as outside machining, the main slide arm is lengthened by preassembly with a double-flanged fabricated extension section some 6ft 3in in length. Outside diameter machining is, with this set-up, performed from the side ram and front table of the main column.

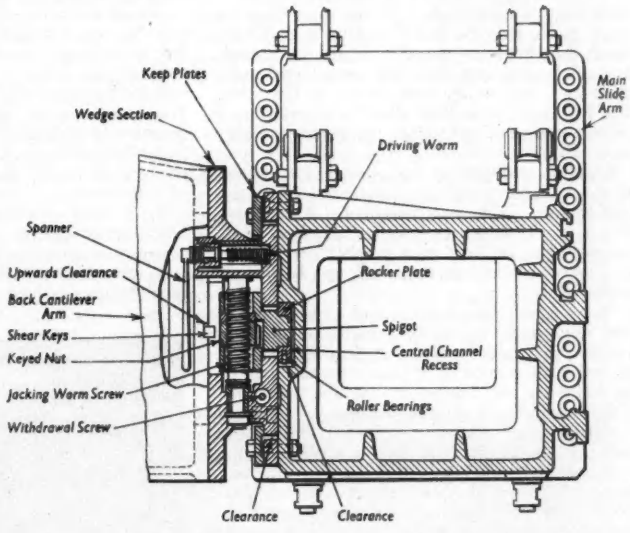
It is obvious that some visible deflection strains will occur in a cantilever member such as this cross-slide arm—in vertical direction due to its own and superimposed weights, in a front to back horizontal plane due to tool-cutting impact loads, and also torsionally about the main axis of the arm due to the forward load of the tool saddle, as well as equipment and tool loads. To counteract these strains the back cantilever arm and back column were introduced into the design and have proved highly successful.

The 22ft 3in high back column is a welded assembly of steel plates and sections and its base is 8ft by 6ft 11in. The position of this column can be adjusted on the floor plates to a considerable extent on axes parallel and at right angles to the face of the main cross-slide. Drilled and dowel holes are arranged in the two machined faces of the front of the column similar to those in the main column, and the back cantilever arm is bolted to these faces. In both main and back columns the distance between the steel facings is accurately machined to form a vertical channel with inclined sides to readily receive and locate the cantilever arms.

The channel recess and facings along the back face of the main slide arm provide a practical method of connecting the back cantilever arm to the main slide to give the necessary rigidity and yet facilitate the set-up and inter-movements of the superstructure. This back cantilever arm is an assembly of four heavy fabricated steel sections.

In each section the inter-flange connections are bolted together with location registers, as on the main slide flange face. Cross-keys on the intermediate faces of the sections take vertical shear stress and on the mating face of the back column a bearing plate is introduced for this purpose, as well as to aid in assembly. The first two sections adjacent to the back column are of similar length and one may be removed if it is desired to bring the back column forward to set it nearer the main table. A closing piece of wedge formation which can be moved along between the back surface of the main slide arm and the third section is designed to facilitate setting-up and provide for the very small errors in the closing distance which are inevitable in so large and complex a structure.

The construction of this wedge closing section and its method of operation can be seen in the drawing we reproduce below. The shear forces between the third section and wedge section are taken by a horizontal key and, in the flange, to which the key is not fixed, the key bears only on the bottom face of the keyway. As the upper surface of the key is clear of the keyway some upward movement of the wedge section can take place. The wedge face abutting to the back of the main slide arm bears against flat facings above and below the centre channel recess and can be tightly locked to these faces by sectional lengths of heavy keep plates extending along the back of the main slide arm. These keep plates are clear of the top and bottom faces of the flange of the wedge, locking only on the thickness of the flange. Standing



Jacking Device for Levelling Up Main Slideways

forward of this flange and accommodated within the channel recess, is a heavy steel rocker plate centrally mounted on a large spigot which is formed on one side of a large and heavy nut contained and guided within the wedge and capable of being raised or lowered on a central screw. This rocker plate has a plain upper surface which can, by a small vertical movement of the nut, engage the upper side of the channel recess.

Recessed in the bottom face at each end of the rocker plate is a heavy roller bearing projecting slightly below the rocker plate bottom face. The distance from the upper face of the rocker plate to the lowest point of the bearing outer diameters is about $\frac{1}{16}$in less than the width of the channel recess. It will be appreciated that downwards movement of the nut will cause the rocker bearings to be brought into contact with the lower face of the channel recess and, provided that the wedge portion was free to

move along the back of the main slide arm, the whole of the wedge would move along supported on these two rollers. If the movement of the screw within the nut was continued beyond that necessary for contact of the rollers the tendency would be to jack up the wedge and, at the same time, to raise the shear key in the joint free of its contact with the key seat. A long screw, passing through the wedge and housed to the back of the main slide arm, is used for the longitudinal traverse of the wedge.

With the wedge in position between the cantilever arm and the face of the main slide arm and secured to each just sufficiently tightly to permit vertical sliding movement, a reverse movement of the jacking screw within the nut will cause the rocker plate to rise until its upper surface presses against the top face of the channel. Continued movement of the nut will first force down the wedge and shear key on to the bottom of the key slot in the flange of the third section of the back arm, and thereafter jack up the main slide arm relative to the back cantilever arm. This is the method used to " level up " the main slide ways and it is interesting to record that as a measure of the accuracy with which this levelling can be effected the surface of the table when faced on site was truly plane across a 25ft diameter to within two thousandths of an inch. After adjustment to level is made, the wedge portion is bolted up solidly to its adjacent members.

During erection the back cantilever arm was test-loaded at its extreme end with a load of 45 tons and the deflections carefully checked. As the loading due to the jacking action of the wedge section is estimated at 20/25 tons, careful measurement of the distances between the faces of section three of the back cantilever arm and the back faces of the main slide, as set up on trial assembly, enabled these dimensions to be corrected to allow for the various strain deflections. The wedge section, which had purposely been left oversize on length was then faced to suit : when inserted and bolted up it gave very acceptable final results with regard to squareness of the tool ram and slide faces to the main table and also to the true centre of the table. The worm-driven jacking screw is operated by a ratchet spanner from within the back cantilever arm.

Careful consideration was given to the various platforms and walkways required. These are clearly seen in the accompanying illustrations and it is of interest to note that the front cross gangway can be fixed in a number of positions in relation to the front slide or it can be entirely removed.

Work of considerable size and an open centre can be mounted on the floor-plates surrounding the machine table, and the main column, with or without the main cross slide arm, can then be mounted on and rotated by the machine table. This inversion of normal boring mill practice is one of the several unusual features of the machine and illustrates the versatility of the sectional method of construction adopted. Other portable machine tools, such as horizontal boring, drilling, slotting and milling machines, can be mounted either on the table or externally on the floor plates. Immediately behind the back column is a 40ft jib, which effectively covers and serves the superstructure and table areas, and carries a 10 cwt lifting block for handling minor items of equipment. It also provides a supporting means for a balanced suspension control box, which may be set at any height and is convenient for the use of an operator situated on the front platform, or down inside large diameter workpieces.

The main electric control system is of B.T.H. manufacture and is in three principal portions : (1) the main control board ; (2) a desk control unit, and (3) a pendant control.

On the main board is the main isolator, switches for the lighting of the speed-indicator panels and optical sighting gear for angular setting of the main table, and power to the a.c. sliprings and sockets on the main table. Adjacent are lights indicating " table alive " and " indexing clutch engaged," together with the locked switch for " boring and turning " or " milling and slotting," which interlocks when the milling head is in use. These are followed by a cubicle for table control movements. The oil pump controls and indicator light are grouped for the main table and for the boring bar drive. A further operating cubicle is for the boring bar drive controls and is similar to that for the main table control.

The trolley-mounted control desk is connected by a multi-core trailing cable and multi-pin plug to either of two socket points at the right and left-hand sides at the front of the machine. This connection enables the desk to be moved to any convenient operating point outside the table and work periphery, from the main column to the opposite side of the table. On the desk panel grouped controls for table and boring bar duplicate those in the main control panel, and there are in addition gear-change push buttons for the main drive gearbox giving six gear changes. Indicating dials clearly show the gear positions.

The pendant control carries the principal controls for the main table and the boring bar and also an emergency stop button.

We are informed that considerable assistance in the machining of the fabricated steel parts of the superstructure for this machine was rendered by the English Steel Corporation, Ltd. ; Craven Bros., Ltd., and Markhams, Ltd., of Chesterfield, for the boring bar, and by Davy and United Engineering Company, Ltd., for the special long-feed screws and shafts. The hand-rails and access platforms were made to specification by Steelways, Ltd. The foundation work was carried out by J. Parnell and Son, Ltd., with steel reinforcement designed and supplied by the British Reinforced Concrete Engineering Company.

Surrey Docks Substation

The new electrical substation at Surrey Docks on the East London Line was formally opened on Tuesday, September 22nd, by Lord Latham, the retiring chairman of the London Transport Executive. Among the improvements embodied in this substation are the introduction of totally enclosed, air-cooled transformers in place of straight-through, air-blast transformers ; the elimination of oil (except in the e.h.t. circuit breakers), and the adoption of unit construction, which simplifies maintenance and permits flexibility of arrangement to suit site conditions.

ON September 22nd, Lord Latham presided at his last official ceremony as chairman of the London Transport Executive—the formal opening of a new electrical substation at Surrey Docks, on the East London Line. At the opening ceremony, Lord Latham was accompanied by Sir Harry Railing, chairman of the General Electric Company, Ltd., the supplier of the electrical equipment for the substation.

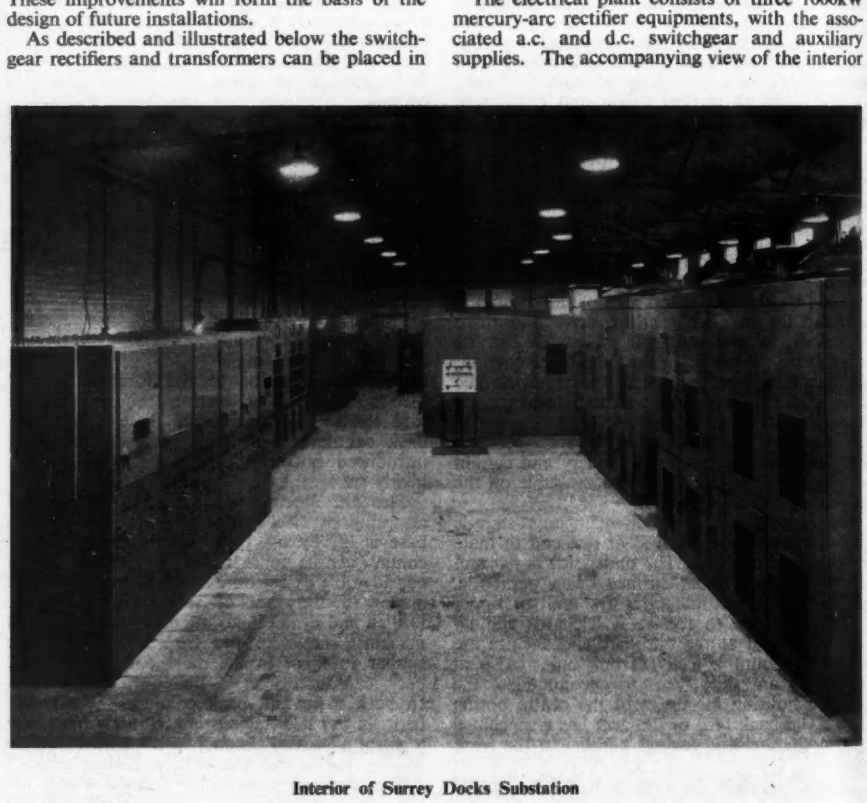
The new Surrey Docks substation replaces one that was bombed during the war. It is the first installation to be completed under the programme, which was initiated during Lord Latham's term of office, for modernising London Transport's power distribution system. The complete installation was built and equipped to the design of Mr. T. S. Pick, the chief electrical engineer of the L.T.E. and it embodies a number of improvements, intended to reduce building costs, simplify maintenance and lessen fire risks. These improvements will form the basis of the design of future installations.

As described and illustrated below the switchgear rectifiers and transformers can be placed in position and withdrawn for maintenance without the need for an overhead crane. A lighter building was therefore feasible, and, as Lord Latham stated in his opening remarks, the building contained only 10 per cent of the steel and 60 per cent of the bricks and cement used in the equivalent pre-war substation ; it was, in fact, a simple functional shell.

The fact that the equipment is built up of transportable units simplifies maintenance and permits considerable flexibility in the layout of subsequent installations. All the equipment is under cover in the main building.

Surrey Docks substation is designed to convert the incoming 11kV, three-phase, 50 c/s supply to 660V two-wire direct current for traction purposes. Normally, the substation will be unattended and will be remotely controlled from Aldwych, but full facilities are provided for local control.

The electrical plant consists of three 1000kW mercury-arc rectifier equipments, with the associated a.c. and d.c. switchgear and auxiliary supplies. The accompanying view of the interior

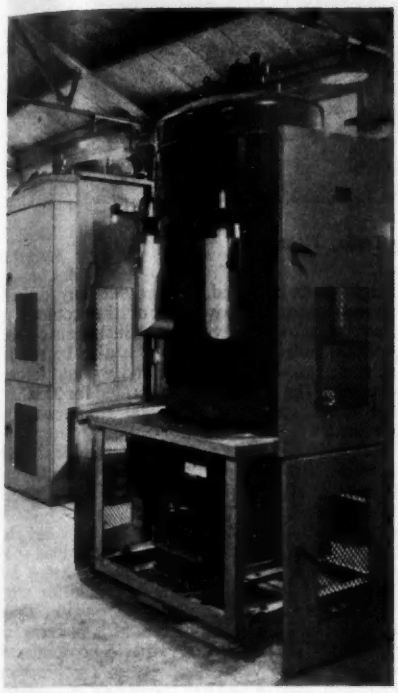


Interior of Surrey Docks Substation

of the substation shows, on the right, two of the three 1000kW rectifier equipments; on the left, facing the rectifiers, is the a.c. switchgear, and in the background is the d.c. switchgear and auxiliary supply board.

11kV A.C. Switchgear

The high-voltage a.c. circuits are controlled by an 11kV, double-busbar, metalclad switchboard comprising six units, one for each of the two incoming feeders, one for each of the feeders to the three rectifier equipments, and one for the supply to the lighting transformer. Each unit is



One 500kW Rectifier Truck Unit Partly Withdrawn

totally enclosed by sheet steel covers and is fitted with a 400A oil circuit breaker of 350MVA breaking capacity. The circuit breakers are arranged for vertical isolation and are mounted, together with their closing mechanisms, on carriages which can be completely withdrawn from the units for inspection and maintenance purposes. Busbar selection is carried out by lowering the breaker and moving the carriage backwards or forwards into registered positions.

The circuit breakers are normally solenoid operated, but facilities are also provided for manual operation in emergency and for maintenance purposes. The ring current transformers have separate 1A secondary windings for protection and metering, and 10A test windings. In addition to standard inverse-time-limit overload and earth-leakage protection, the rectifier circuit breakers are fitted with quick-acting overload trip coils which are set to operate instantaneously at five to six times normal full load. Neon voltage indicators are provided for the incoming feeders, thereby dispensing with potential transformers. The switchgear is equipped for frame-earth fault protection, the whole board being lightly insulated from earth except at one point where a definite earth connection is made through the primary of a 300/1 current transformer.

Associated with the main a.c. switchgear is a relay board consisting of seven totally enclosed sheet steel cubicles, one for each of the incoming feeders, rectifier and lighting transformer supply circuits, and for the frame-earth fault protection apparatus. The protective and control relays and the rectifier ammeters are flush mounted on the front of the board, while test terminals and operating fuses are housed inside each cubicle.

Mercury-Arc Rectifiers

In all there are three 1000kW, 660V, steel tank rectifier equipments, each comprising two 500kW, six-anode cylinders of the company's standard pumpless, air-cooled design, together with their transformers. The two cylinders normally operate together as a twelve-phase unit, but, if necessary, either one can be isolated and run as a separate unit.

The rectifiers are draw-out equipments, each cylinder being mounted on the top plate of a wheeled truck above its auxiliaries. After disconnecting a few external leads the truck can be completely withdrawn from its sheet steel cubicle, giving access to all components for inspection and maintenance. The six complete truck-mounted units are interchangeable.

Each 500kW rectifier cylinder has its own individual main transformer which steps down the high-voltage supply in the ratio 11,000/593V (phase to neutral). Each transformer is air-blast cooled, with a closed air circuit, and is installed at the back of the associated rectifier unit so that the end of the transformer case forms the rear wall of the rectifier cubicle. If the end cover of the case is removed and certain internal leads are disconnected, the transformer core and windings, which are mounted on rollers, can be withdrawn from the case through the rectifier cubicle.

Of the two transformers in each 1000kW bank, one has a star-connected and the other a delta-connected primary winding, so that there is a phase displacement of 30 deg. between the outputs of the two units. In each case the secondary is connected in double star though a 150 c/s interphase transformer to give the necessary six-phase output. For twelve-phase working, the two units are interconnected through a 300 c/s interphase transformer. Rectifier ignition and fan motor supplies are taken from 242V tertiary windings which also provide the operating supplies for certain protective relays. Primary tappings are provided at plus and minus 2½ and 5 per cent, off-circuit tap changing being effected by means of links. Class B insulation is used throughout.

The cooling unit, which is mounted on top of the transformer case, as illustrated below, is a Serck air/air heat exchanger. The hot air is drawn through the exchanger tubes by an Aerofoil single-inlet fan, directly driven by a 3·5 h.p., 1440 r.p.m. motor, while cold air is drawn over the outside of the tubes by an axial type fan driven by a 0·375 h.p. motor. A contactor box which houses the protective gear and isolating switch for the fan motors is mounted on the side of each transformer case.

D.C. Switchgear

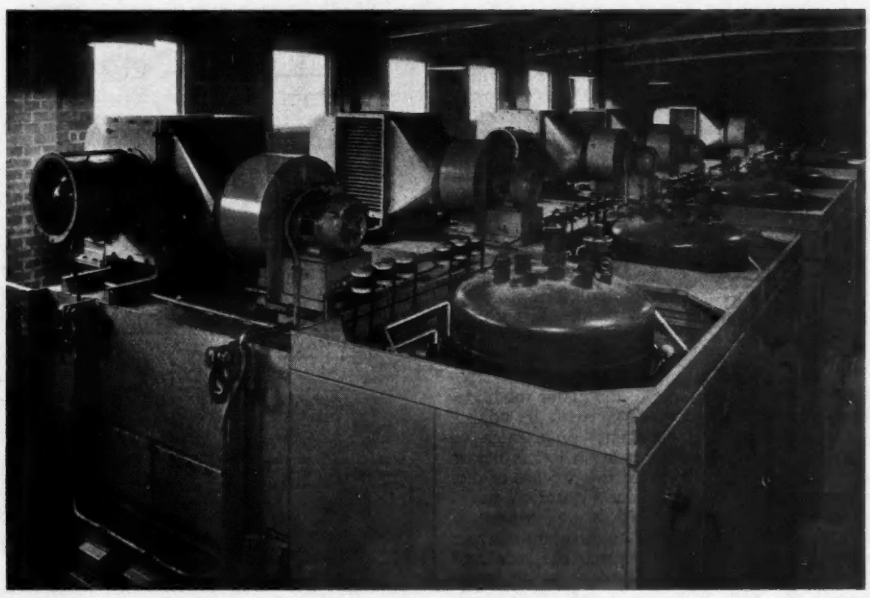
The 660V d.c. busbars are divided into three sections interconnected through 3000A busbar selector contactors of the " Salford " line contact design. Each section is fed from one 1000kW rectifier equipment, the positive connections being made through 3000A reverse-current, high-speed circuit breakers, while the negative contactors are of line contact design. Two track feeders are taken from each of the two outer busbar sections, the positive feeders being controlled by overload high-speed circuit breakers and the negative feeders by line contact contactors. In each circuit, the positive circuit breaker and negative contactor are electrically coupled so that they close and open in sequence. Surge diverters are fitted to the outer sections of each busbar. To avoid overvoltage under low-load conditions, a load resistor is provided for each 1000kW rectifier equipment. This resistor is automatically switched in by a main load relay and contactor as soon as the rectifier load drops below 28A, the combined transient load of the two transformers.

The whole of the d.c. switchgear is assembled to form two nine-panel, truck cubicle switchboards which are installed back-to-back with a gangway between. One board houses the positive high-speed circuit breakers and busbar selector units (one of these circuit breaker trucks is shown partly withdrawn on page 438, while the other contains the equivalent negative switchgear. In addition, on the end of each board is mounted a small test cubicle fitted with the necessary control switches and jumper connections for testing the high-speed breakers and the contactor when withdrawn from the board. The circuit breakers, together with their auxiliary contactors, are mounted on draw-out trucks, interlocks being provided in each case to ensure that the truck cannot be withdrawn from its cubicle until the circuit breaker has been tripped. The load resistors are mounted above the rectifier negative contactor cubicles.

The substation auxiliary supplies are controlled from a combined a.c. and d.c. switchboard fed from the 300kVA, 11,000/415/240V oil-immersed lighting transformer. This board comprises four totally enclosed sheet steel cubicles, one for the 500A circuit breaker controlling the supply from the transformer, one for the 415V feeders to the compressor motor and signal motor generator sets, a third for the 240V lighting and battery trickle charger circuits and a fourth to control the circuits supplied from the 50V tripping battery and the 110V operating battery.

Operation

The rectifiers are started automatically by closing the associated oil circuit breakers to energise the transformers, ignition of the two cylinders in each equipment taking place simultaneously. A sequence contactor is energised through auxiliary anode load relays as soon as both cylinders have ignited, and auxiliary contactors then operate to close first the high-speed circuit breaker and then the negative contactor, which connects the equipment to the d.c. busbars. Where only one cylinder of an equipment is operating, the normally open contact of the



Rectifiers and Transformer Cooler Units

isolated auxiliary anode load relay is cut out from the closing circuit by means of a shorting link so that the closing of the sequence contactor depends only on the ignition of the live cylinder. Time delay relays are provided between the auxiliary anode relays and the sequence contactors to ensure that the sequence contactors and d.c. circuit breakers will only open on sustained failures in auxiliary anode ignition. The track-feeder and busbar-selector circuit breakers are electrically operated by means of 660V closing and tripping contactors. Busbar/track selector contactors are provided so that the feeder breakers can be closed when the d.c. busbars are dead.

The 11kV a.c. oil circuit breakers trip automatically when their protective devices operate. Most of the relays are self-resetting, but certain lock-out facilities are embodied in the rectifier feeder circuits. Operation of the lock-out relays is initiated by earth faults on the main transformers or isolating transformers, by failure of the transformer or rectifier fan drives, and by repeated starting-sequence failure after three restarts have been attempted. The occurrence of any of these faults is indicated by a lock-out alarm on the supervisory panels at Aldgate and, locally, by a lock-out indicator ; in each instance local inspection and hand resetting of the relay are necessary. In the event of transformer fan failure, the faulty motor is indicated by a flag relay at the front of the contactor box mounted on the transformer case. Forced transformer cooling may not be required during low-load periods and, under these circumstances, the fans are switched off at the contactor box, the tripping circuit of the associated circuit breaker being automatically cut out at the same time.

The track feeder circuit breakers trip automatically at overcurrents dependent upon the settings of calibrating resistors mounted on the high-speed circuit-breaker trucks. These settings are adjustable between 3000A and 6000A by means of six-way stud switches. The circuit breakers can also be tripped by operating the tunnel trip wires to de-energise the tunnel trip contactor, thus breaking the circuit to the hold-on coil. In an emergency, the high-speed circuit breaker can be reclosed before the tunnel trip contactor is re-energised, by operating a latched push button on the front of the truck cubicle. All the track feeder high-speed breakers are designed to hold in at d.c. busbar voltages down to 400V.

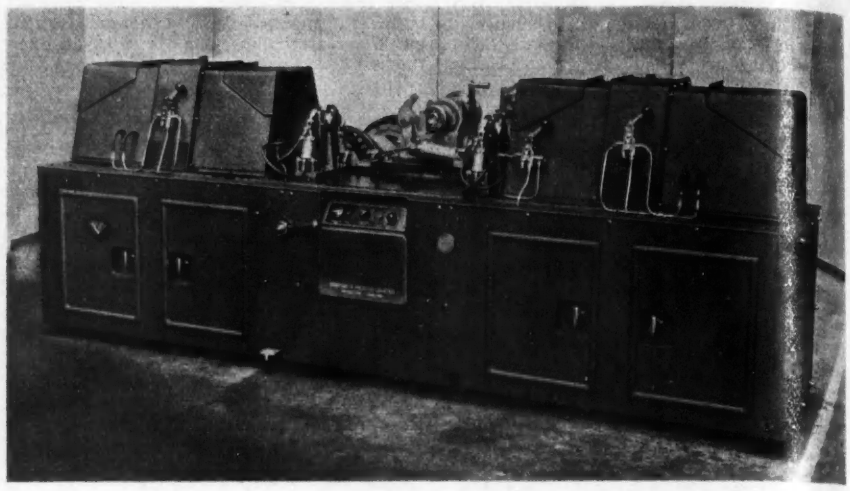
The General Electric Company, Ltd., has supplied the complete rectifier equipment with its associated a.c. and d.c. switchgear, lighting transformer, auxiliary supply board, 110V operating battery, main and multi-core cables and the station earthing installation. In addition, the company is supplying the remote and local telecontrol panels with a 50V battery for supervisory and tripping supplies.

Rear Axle Test Plant

A REAR axle test plant, designed by Heenan and Froude, Ltd., has been installed by British Timken, Ltd., at its works at Duston, Northampton, as part of a programme to expand bearing development facilities. This plant, which is illustrated herewith, is to be employed chiefly in research into characteristics of bearings as fitted in various forms of rear axles, for it has been found that valid and consistent data on bearing life can be obtained from tests in controlled conditions. It will be apparent that such a testing machine, while capable of adjustment to various axles and to various conditions of power and speed, must also be capable of repeating preset conditions indefinitely.

The rear axle testing machine standardised by Heenan and Froude, Ltd., was found to be adaptable for these requirements, the major modification being to increase the range of the adjustments provided for accommodating axles of varying dimensions. The axle on test is motor driven and in order to avoid the expense of d.c. electrical generators for power absorption, use is made of the inertia forces of rotating flywheels.

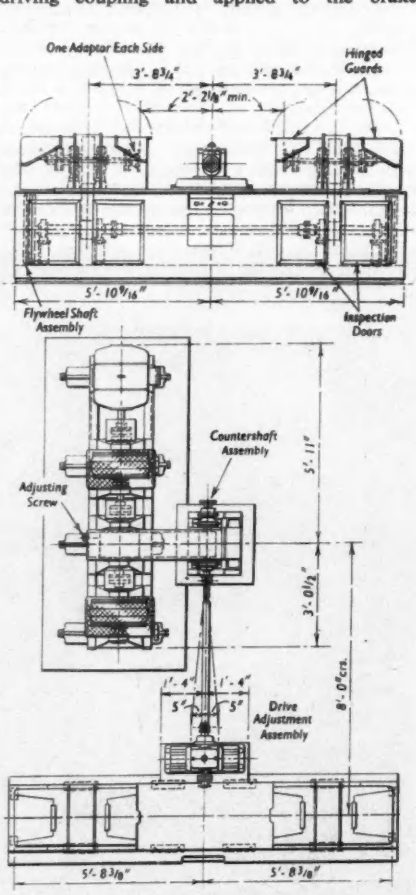
The principle consists of accelerating the axle on test to some suitable speed, the axle half shafts being coupled to tailstocks which incorporate vee belt drives to a set of flywheels housed in the main body of the machine ; the torque transmitted thus depends on the rate of acceleration and the inertia of the flywheels. Interesting means are employed both for obtaining speed variation of the power input to the axle, and for creating a load to decelerate the flywheels at a controllable rate so as to provide a variable over-drive torque.



Standard Rear Axle Testing Plant

The driving motor runs at constant speed and is coupled by a Heenan-Dynamatic controlled-slip coupling to a countershaft. This countershaft carries the driving pulley of a vee belt drive to the axle input shaft, and a further Heenan-Dynamatic coupling of which one member is locked so as to convert this coupling into a variable eddy current brake. By automatic electronic control gear the axle, and consequently the inertia flywheels, can be accelerated at any suitable rate to a chosen speed. At this point excitation is automatically removed from the driving coupling and applied to the brake coupling, as required, to provide any desired overrun torque, derived from the consequent deceleration of the flywheels. Such tests can be repeated indefinitely ; tests can also be run at constant speed without load and without torque reversal. The driving motor is rated for 35 b.h.p. and input speeds up to 4000 r.p.m. can be obtained.

The axle on test is rested upon vee blocks and there gripped by pneumatically operated clamps. The half-shaft ends are coupled to their tailstocks by sliding the latter into engagement by pneumatic pistons, the pneumatic gear levers and the controls for speed and load being grouped conveniently for the operator. The headstock for the axle input shaft (which can slide for axial engagement) can be adjusted sideways, to cater for axles in which the differential is placed non-centrally. The headstock can also be positioned to suit various vertical offsets of the propeller shaft. A cardan shaft is employed to connect the headstock to the driven member of the vee belt transmission.



Arrangement of Rear Axle Test Plant

Technical Reports

Catalytic Enrichment of Industrial Gases by the Synthesis of Methane. By Fuel Research Station, Blackwall Lane, Greenwich. H.M. Stationery Office. Price 2s. 1½d., post free.—This report describes work carried out at the Fuel Research Station, Greenwich, with the object of developing a process suitable for large-scale operation for the catalytic synthesis of methane from the carbon monoxide and hydrogen contained in water gas and other industrial gases.

The work was begun in 1939 with the object of making gas from which liquid methane could be produced as a fuel for road transport. After the war emphasis was transferred to the possibilities of producing town gas from water gas without the use of imported oil. The report describes experiments with both laboratory scale apparatus and small pilot plant.

The major problem was that of dissipating the heat of reaction, because excessive amounts of carbon are formed if the temperature of the nickel catalyst used is allowed to rise above 500 deg. Cent. Two methods of solving this problem are described in the report. In the first there were narrow beds of catalyst separated from one another by narrow compartments containing a liquid at a suitable temperature. The second method used a perforated sheet metal cylinder to contain the catalyst, the gas passing along the space between this cylinder and a surrounding cooled wall and having access to the catalyst only through the holes in the cylinder. In plant processing 200 cubic feet of water gas per hour both methods gave satisfactory results, the total yield of methane per pound of catalyst used being 2000 lb to 3000 lb. The second method is preferred for use in full-scale plant, as the formation of carbon is almost completely eliminated. Full-scale plant to process 20,000 cubic feet of water gas per hour would use about 100 reactor tubes enclosed in a single cylindrical water jacket, perhaps 12ft high and about 2ft in diameter.

Although the experiments described have been carried out with gas at atmospheric pressure it is believed that similar plant could be operated satisfactorily at higher pressures and that the formation of carbon could be controlled without difficulty.

The Engineering, Marine and Welding Exhibition

No. IV—(*Concluded from page* 390, *September 25th*)

HERE we conclude our descriptive review of some of the exhibits at the Engineering, Marine and Welding Exhibition which closed at Olympia recently.

Rolls-Royce, Ltd.

In addition to showing a skid-mounted generating set consisting of a flange-mounted 75kW Macfarlane three-phase, four-wire, 50c/s alternator driven by a Mk. C6NFL normally aspirated oil engine, Rolls-Royce, Ltd., Derby, showed a supercharged marine engine, which can be seen in Fig. 36.

This six-cylinder in-line, four-stroke, direct-injection engine, Mk. C6SFLM, has a bore of 5½in and a stroke of 6in and is rated at a maximum of 250 b.h.p. at 2100 r.p.m. for intermittent operation and 200 b.h.p. at 1800 r.p.m. for maximum cruising in medium-speed craft. There is an integral cast iron crankcase and cylinder block fitted with cast iron wet liners and the same material has been used for the cylinder heads, which carry the push-rod-operated overhead valves. The aluminium alloy pistons have three compression rings, the upper one being chromium plated, and one scraper ring all fitted above the gudgeon pin. Connecting-rods of En. 24 steel are fitted and have a lead-bronze bush at the small end. Lead-bronze indium flashed thin shell steel-backed bearings carry the seven bearing nitride hardened En.19 alloy steel crankshaft, which has at the front end a viscous silicon torsion damper. Aluminium alloy has been used for the sump, exhaust manifold, rocker cover and heat exchanger casing, and gear wheels are generally of En. 36 steel carburised and hardened.

A fresh water thermostatically controlled closed-circuit cooling system is fitted, in which the water passes via the thermostat to the heat exchanger through the pump, down to the lubricating oil heat exchanger before passing to the cylinder block heads and exhaust manifold. Salt water is circulated by a centrifugal pump driven from the forward end of the crankshaft. Dry sump lubrication system with heat exchanger is embodied and there are three lubricating oil gear pumps, namely, two scavenge pumps and one pressure pump, and the oil passes through full-flow filters and strainers.

C.A.V. fuel injection equipment is fitted including a lift pump and triple filters, and supercharging is by a positive displacement gear-driven Roots blower, which gives a boost of about 8 lb per square inch at the maximum governed speed of 1800 r.p.m. A Burgess air silencer and cleaner is provided. Starting is by a 24V electric motor, and there is a 24V dynamo belt-driven from the wheel case. The final drive is through a Mathway reverse reduction gear.

Crompton Parkinson, Ltd.

Squirrel-cage motors with standardised dimensions formed the basis of one of the exhibits shown by Crompton Parkinson, Ltd., Crompton House, Aldwych, London, W.C.2.

These motors are designed and built to comply with the British Standard "Draft C.N. (Elec.) 6814," which standardises outputs, shaft sizes and fixing dimensions. The range of motors is from ½ h.p. at 750 r.p.m. up to 25 h.p. at 3000 r.p.m. and includes ratings at 750, 1000, 1500 and 3000 r.p.m. to suit a variety of industrial drives. With the exception of the smallest frame size, which is totally enclosed without fan cooling, all the other sizes are totally enclosed fan cooled machines, as illustrated in Fig. 37.

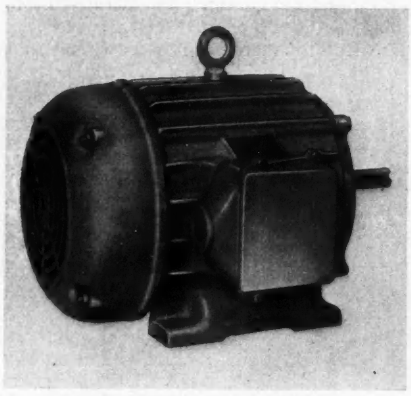


Fig. 37—Fan-Cooled Standard-Dimension Motor —Crompton Parkinson

All the motors incorporate the company's standard practice for squirrel-cage induction motors. The stator winding consists of copper wire insulated by a polymerised synthetic enamel, with Micanite slot insulation. The wound stator is dried, treated with a synthetic resin varnish and baked; the varnish polymerises and sets, making the windings both permanent and rigid at all working temperatures, and resistant to moisture, corrosive atmospheres and grease.

Mirrlees, Bickerton and Day, Ltd.

On the stand of the Brush Group, Mirrlees, Bickerton and Day, Ltd., Stockport, showed several examples of the company's Mk. J engines. There was a "J6" naturally aspirated, six-cylinder, in-line engine coupled to a Brush d.c. generator having a continuous rating of 225kW at 750 r.p.m., and two main propulsion engines, each shown coupled to oil-operated gears supplied by Modern Wheel Drive, Ltd. One of the latter was a Mk. J.D.8 direct reversing, eight-cylinder, in-line, naturally aspirated engine which has a bore of 9¾in by 10½in stroke, and develops 373 s.h.p. at 600 r.p.m. The other main propulsion engine was a J.V.S.S.12 unit, illustrated in Fig. 38, which is a twelve-cylinder vee pressure turbo-charged, four-stroke diesel engine developing 1250 s.h.p. at 750 r.p.m.

The bedplate is of fabricated steel, welded and stress relieved and incorporates the engine sump, while the cylinder housing is of similar construction and is arranged to accommodate exceptionally large inspection covers giving complete access to main bearings, big-end bearings, camshaft, fuel pumps, &c. Cast cylinder iron is used for the liners and also for the cylinder heads, each of which carry two exhaust, two inlet valves, a centrally placed injector, a starting non-return valve and a cylinder relief valve. The light alloy piston has a combustion chamber in the crown and is fitted with four compression rings, and one scraper ring above the gudgeon pin and one scraper ring below it. An "H" section steel forging, hardened and tempered, forms the connecting-rod, which has a phosphor-bronze small end bearing and a white-metal-lined big end bearing, and the crankshaft is a hardened and tempered steel forging carried in steel shell white-metal-lined bearings. The camshafts, of high-tensile steel ground bar, are located in detachable

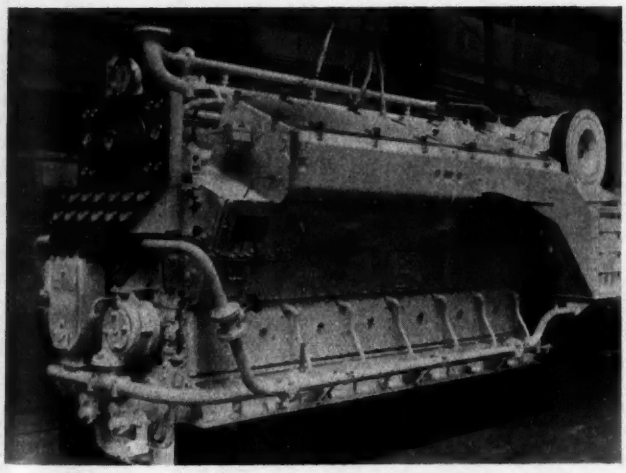


Fig. 36—Six-Cylinder Marine Oil Engine—Rolls-Royce

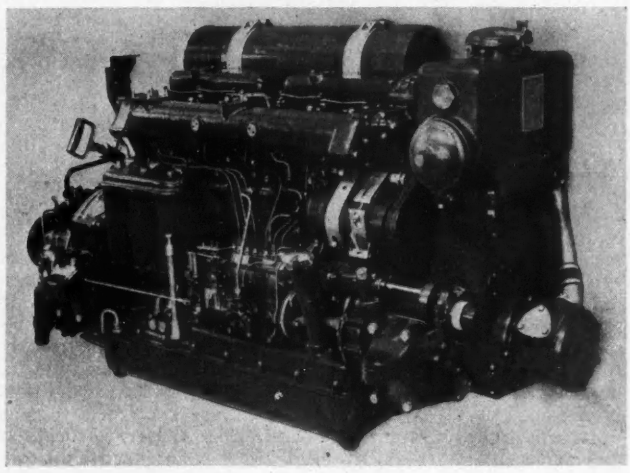


Fig. 38—Twelve-Cylinder Vee Engine—Mirrlees, Bickerton and Day

phosphor-bronze bearings and carry cam sleeves with chill cast cam profiles.

Two exhaust gas turbo-driven compressors with built-in air filters, are mounted on the engine and fuel is supplied to the cylinders by individual pumps. A belt-driven centrifugal pump circulates the cooling water around the engine and through the lubricating oil cooler, and the engine is pressure lubricated throughout, the lubricating oil pump being gear driven.

Bolinders Company, Ltd.

On its stand the Bolinders Company, Ltd., showed several single, two and three-cylinder Bolinders engines in various forms, together with a number of single, two, four and six-cylinder "Penta" engines.

The single- and two-cylinder Bolinders industrial diesel engines develop 11 and 22 b.h.p. respectively, and represented new design models. The photograph reproduced in Fig. 39 shows a three-cylinder industrial engine, which has a bore of 4⅛in by 5⅛in stroke, and develops 33 b.h.p. at 1500 r.p.m., the brake mean effective pressure being 84 lb per square inch. The engine is a vertical, water-cooled, four-stroke unit with direct injection and has a compression ratio of 16·5:1. The cylinder block and crankcase form an integral casting of cast iron and the cylinder head is a molybdenum alloy casting incorporating the nozzles in water-cooled copper bushes. Wet pattern cylinder liners, centrifugally cast, are fitted and there is a cast oil sump, with a capacity of 1·75 gallons.

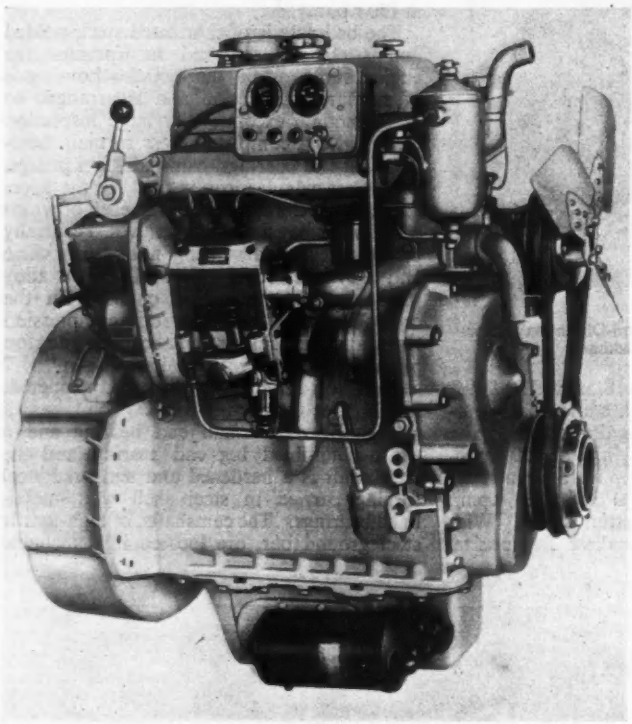


Fig. 39—Three-Cylinder Industrial Engine—Bolinders

Aluminium alloy pistons are fitted and have three compression rings and one oil scraper ring above the gudgeon pin and one scraper ring below. The top compression ring is hard chromium-plated. Bronze bushes form the small-end bearings and lead-bronze-lined steel shells the big-end bearings of the drop forged connecting-rods, while the crankshaft, of chrome-manganese heat-treated steel, is carried in four main bearings of lead-bronze-lined steel shells. The camshaft, which is a drop forging, has case-hardened and ground cams and bearing surfaces and the exhaust valves have Stellited faces.

A gear pump supplies lubricating oil under pressure to all bearings and valve mechanism and a belt-driven pump circulates the cooling water.

A marine version of the three-cylinder engine was shown complete with heat exchanger, sea-water pump, bilge pump, electric and auxiliary hand starting, and fitted with an oil-operated reduction gear giving the propeller a speed of 600 r.p.m. The "Penta" models included some petrol/paraffin engines and direct-injection diesel engines suitable for the propulsion of small craft. Models of both 100 b.h.p. and 150 b.h.p., six-cylinder diesel engines were shown and there was also a twin-engine installation of the 150 b.h.p. model exhibited in association with an oil-operated reverse reduction gear provided by Modern Wheel Drive, Ltd.

Wade Engineering, Ltd.

Superchargers of various capacities were shown by Wade Engineering, Ltd., Horley, Surrey, and also examples of variable compressors, air motors, air cycle temperature control units and turbo-extractors.

The turbo-extractor, manufactured by the company is, in effect, a rotary scavenger designed to increase horsepower without increase in fuel consumption, the average increase in horsepower being approximately 8 and 5 per cent for two-stroke and four-stroke diesel engines respectively, and up to 15 per cent for a four-stroke petrol engine. The turbo-extractor is designed on a basis of unit construction and not only serves to lower the pressure at the exhaust port, but picks up energy from the exhaust gases so that no power is absorbed from the engine. The housings are insulated in aluminium alloy and are remote from the working chambers, which are of high-duty Meehanite and have end plates of the same material. Shafts and rotors are fabricated from formed tubing of high-temperature non-scaling steel, ground form gears and roller bearings are fitted.

The temperature control unit has been developed on the air cycle principle and has been designed to control the temperature of a space of small volume. It is easily transportable and is capable of maintaining any temperature above 50 deg. Fah. within ±5 deg. Fah. for a volume of approximately 2000 cubic feet, having four changes of air per hour. The unit consists of a positive displacement compressor and decompressor coupled to an electric motor and the air passes through air-to-water exchangers to produce to the correct degree of refrigeration. In the heating cycle the shaft horsepower absorbed is passed into the air stream. The dimensions of the unit are about 4ft 8in by 4ft by 2ft 8in, and it is designed to operate for 15,000 hours between overhauls, while the power absorbed is 7·5 h.p. to supply between 70 to 100 cubic feet of air per minute at 50 deg. Fah. with an intake temperature equivalent to that obtaining during a normal summer.

Self Changing Gears, Ltd.

On the stand of Self Changing Gears, Ltd., Lythalls Lane, Coventry, were examples of the company's marine gearbox and reduction units, together with a combined gearbox and reversing unit for railcars and a final drive unit.

The "R.R.F.15," seen in Fig. 40, is a five-speed epicyclic gearbox combined with an air-operated spiral bevel gear reversing mechanism. The gearbox section, which is housed in a high-quality aluminium alloy casting, is of the compound epicyclic design, with a top gear ratio of 1 to 1 and a similar

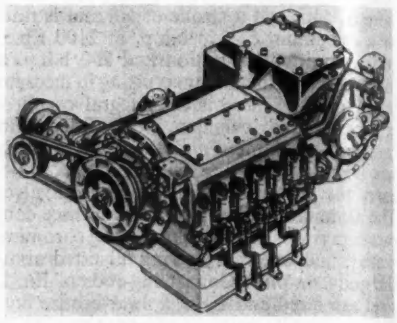


Fig. 40—Railcar Gearbox—Self Changing Gears

ratio through the reversing unit. A bottom gear having a specially low ratio of 6·5 to 1 is incorporated to enable a railcar to ascend gradients of up to 1 in 40 and a special double planet arrangement keeps the gears giving this ratio as compact as possible. Normal epicyclic compounding is used to obtain all indirect ratios and a band brake holds the reaction member for each gear. A multi-plate clutch, operated by pistons in the front cover, engages the straight-through-drive top gear.

For operating the gearbox to effect a gear change, electrical switches are connected to electro-pneumatic valves mounted on the gearbox, and a movement of the driver's control energises the valve, which allows compressed air to enter the appropriate gear cylinder. A simple piston acting through a toggle mechanism applies a band brake to bring the reaction member of the required gear to a standstill and compounding of the epicyclic gear trains gives the desired ratio. The controls consist of a direction lever, a gear lever and a locking device which prevents the railcar from being set in motion by an unauthorised person. With the safety lock released the direction lever is moved to the forward or reverse position and until that is done the gear lever cannot be moved, but once the gear is selected then the direction is locked in position.

A plunger pattern pump supplies oil under pressure to all moving parts but, since the running gear is not submerged in oil, churning is reduced to a minimum and the oil returns by gravity to the sump which is common with the reversing unit. A three-point suspension is used, employing Silentbloc rubber bushes, and vee-belt auxiliary power take-off is fitted and a drive provided for a generator feeding an electrical speedometer.

The one-piece reduction gear casing is a

stress relieved aluminium alloy casting housing the case-hardened and lapped spiral bevel gears in which the input pinion drives two wheels mounted freely on a shaft. A sliding dog is engaged with one of the wheels by a selector shaft moved by an air operated piston. Lubrication is by a bi-directional rotor pump driven from the cross shaft.

The gearbox and reversing unit is connected to the final drive unit, Mk. RF.24, which has a capacity of 5200 lb per foot, through two universal couplings and a Hardy Spicer shaft. A high-quality cast-steel casing with ribbing designed to minimise distortion is employed and the spiral bevel gears are case hardened and lapped in sets. The unit is axle mounted and a link torque arm is fitted in association with compressed rubber bushes to take torque and shock loads.

Brookhirst Switchgear, Ltd.

Examples of newly designed a.c. and d.c. marine motor starters for use with three-phase squirrel-cage motors were shown by Brookhirst Switchgear, Ltd., Chester.

The equipment illustrated in Fig. 41 is a 27½ h.p., 400/440 V "Comprehensive" straight-on starter designed to comply with Lloyd's "Rules for Electrical Equipment." This starter incorporates a triple-pole main

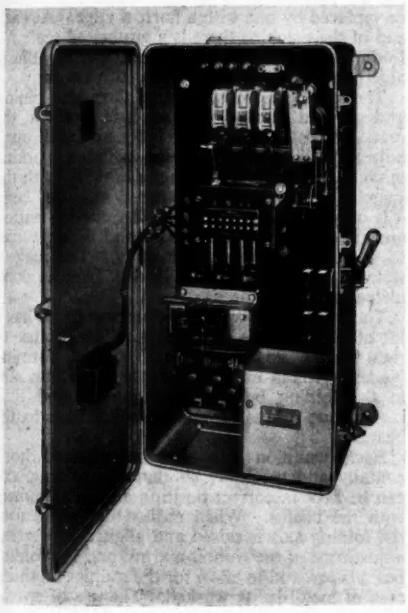


Fig. 41—Straight-on Starter—Brookhirst

contactor having rolling butt contacts, magnetic blowouts and arc shields. Overload protection is given by triple-pole indirectly heated thermal trips, with ambient temperature compensation; alternatively solenoid-operated trips with dashpot timelags are fitted, operation being through current transformers in the larger sizes. Either form of trip is designed to open the contactor on sustained overloads, but not on momentary overloads during running nor on normal starting peaks. A no-volt release is embodied and, in association with the overload trips, provides free-handle operation.

A triple-pole isolator is fitted in a closed compartment at the bottom of the switch case and is interlocked with the contactor and the door of the case.

The electrical equipment is housed in a totally enclosed drip-proof, bulkhead-mounting, sheet-steel case, with a hinged front having a packed joint. Among the optional extras which are available are an ammeter, pilot lamp, h.r.c. control circuit fuses, a weather-deck water-tight case and a hoseproof case. Another optional item is the fitting of a voltage transformer (as in Fig. 41) to provide a 110V supply for the pilot lamp and controls.

R. A. Lister (Marine Sales), Ltd.

Besides showing a number of small units, the main display on the stand of R. A. Lister (Marine Sales), Ltd., Dursley, was three sets of paired engines, each set driving through twin oil-operated reverse reduction S.L.M. gearbox, supplied by Modern Wheel Drive, Ltd.

The smallest main propulsion combination was a pair of Mk. F.R.M.6 "Freedom" engines, each capable of developing 54 b.h.p. at 1800 r.p.m., and each coupled to a Mk. 2MWR, size 0, S.L.M. gearbox having a 4 : 1 reduction ratio and delivering 100 h.p. to a single propeller shaft. The engines are six-cylinder units having a bore of 3·75in by 4·5in stroke, and a brake mean effective pressure of 76·5 lb per square inch on continuous rating. Another multi-engine exhibit consisted of two "616 M.G." engines having a bore and stroke of 4·5in and 5·5in respectively, and rated to develop 62 b.h.p. at 1200 r.p.m. These engines are coupled to a 2MWR size 0, S.L.M. gearbox incorporating a 4 : 1 reduction ratio and having an output of 125 h.p.

The third multi-engine set is to be installed on board the Norwegian ferry, M.S. "Dyroy," and consisted of two Blackstone E.V.M.8 engines which have a bore of 8½in by 11½in stroke, and develop 360 b.h.p. at 600 r.p.m. Both engines are connected by a flexible rubber coupling, incorporating a viscous oil damper of constant shear wedge pattern to cut out torsional vibration, to a 2MWR, size 3, S.L.M. oil-operated gearbox having a reduction ratio of 2 : 1 and delivers 720 b.h.p. at 300 r.p.m. to a single shaft.

New Process Welders, Ltd.

The exhibits shown by New Process Welders, Ltd., Nelson Place, City Road, London, E.1, included a spot welding machine specially designed to the customer's requirements for welding the intersection joints of wire reinforcements in concrete pipes.

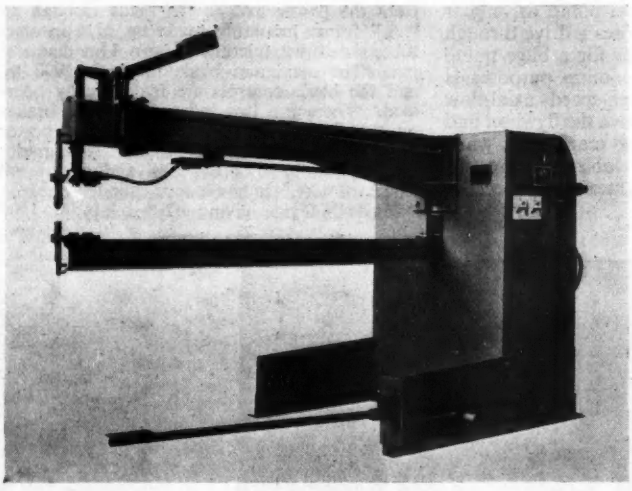


Fig. 42—Spot Welder with 9ft Throat—New Process Welders

The material to be welded varies from No. 10 gauge to ⅜in diameter and the cylindrical reinforcements are 9ft long. To accommodate this length of reinforcement the maker had to design and build a machine with a 9ft throat (Fig. 42). The arms are believed to be the longest fitted to a spot welding machine. Despite the length of arm it was found that the inductance of the secondary circuit could be kept low by, for example, using brass for the leads to the electrodes. The transformer arrangement is such that the power demand on the heaviest work for which the welder was designed does not exceed 20kVA.

To meet the customer's requirements the equipment is mechanically operated by a foot pedal; no compressed air supply is required.

Stothert and Pitt, Ltd.

The exhibits shown by Stothert and Pitt, Ltd., Bath, included a Wilson ship's cargo winch, which is powered by a 60 b.h.p.

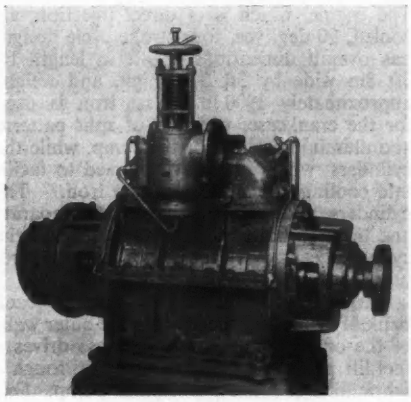


Fig. 43—Screw Displacement Pump—Stothert and Pitt

remote controlled motor and has a rated lifting capacity of 10 tons at 74ft per minute, and a number of rotary and screw displacement pumps. These pumps are examples of units intended for fuel and lubricating oil services and for handling water and also high viscosity fluids at rates ranging from 2 to 320 tons per hour.

As an example of a small reversing flow rotary displacement pump a unit suitable for road tankers was on view and this has an output of 3800 gallons per hour at 50 lb per square inch and 600 r.p.m. Among the screw displacement pumps, one of which is shown in Fig. 43, was a demonstration unit which had been built to show the lifting capabilities of this form of pump, which in this instance was a pump having a suction lift of 20ft and capable of delivering 100 gallons per minute at 20 lb per square inch when driven at 1440 r.p.m. This design of pump is available in vertical form and a pump, for forced lubrication duties, having a capacity of 12,000 gallons per hour at 50 lb per square inch and at 1150 r.p.m. was shown. Also on the stand was the latest development of screw displacement pump which has been designed for duties in

connection with the burning of high-pressure oil fuel and the pump shown is capable of delivering oil fuel, at a temperature of 230 deg. Fah., at a pressure of 1000 lb per square inch when driven at 3000 r.p.m.

In this design of pump the pumping elements consist of two shafts each having a left and right-hand screw, the shafts being carried in ball and roller bearings and the drive being transmitted through case hardened gears. The screws are not in contact and displacement is effected between them as they rotate, the fluid being drawn through the suction branch along the body from each end to the centre, where it is discharged in an almost pulseless flow.

PETTERS, LTD.

Among the engines shown by Petters, Ltd., Staines, Middlesex, on the stand of Associated British Oil Engines, Ltd., was a new model, Mk. P.B.V.6, which develops 60 b.h.p. at 1500 r.p.m. or 55·5 s.h.p. with propeller shaft coupling and reduction gear. The engine, which is of direct injection, air cooled, 90 deg. vee, four-stroke cycle design, has overall dimensions of 4ft in length by 3ft 8in wide by 3ft 3⅜in high, and weighs approximately 1900 lb. Cast iron is used for the crankcase, which is of split pattern, and aluminium alloy for the sump, while the cylinders which are heavily finned to facilitate cooling are of special cast iron. The cylinders and cylinder heads are separate and through bolted to the crankcase and the cylinder heads carry the valves and pressure-lubricated rocker gear.

There are two camshafts, one for each bank of cylinders, fitted within the outer walls of the crankcase, and one of these drives a fuel lift pump, which supplies fuel through a fabric filter to a dustproof block pump. This is mounted between the cylinders and is driven by a gear train from the crankshaft. The pistons are of aluminium alloy and incorporate a hemispherical combustion chamber and are fitted with two scraper and three compression rings, the upper one of which is chromium plated. Fully floating gudgeon pins are used and the connecting-rods have copper-lead-lined big-end bearings. A Berger starter is mounted at the gear end of the engine and the engine is controlled at all speeds by a totally enclosed centrifugal governor fitted on the fuel pump drive gear wheel. For marine purposes a drive through the starter provides power for a bilge pump and dynamo. Air for cooling purposes is provided by a 15in high-speed axial-flow fan centrally mounted above the flywheel and driven by a belt from the crankshaft, while an adequate supply of cooling air to the cylinders is ensured by means of specially shaped cowlings.

A.E.C., LTD.

Examples of marine propulsion, stationary, industrial and rail traction units were exhibited by A.E.C., Ltd., Southall. They included a 100 b.h.p. marine engine with reverse and 3 : 1 reduction gear, fresh water cooling and dry sump lubrication, a stationary engine direct coupled to a 60kW MacFarlane self-regulating alternator, a twin 11·3 litre industrial engine unit having a power output of 250 b.h.p. and designed for oilfield duties, and a horizontal rail traction engine.

In the rail traction engine, which has a bore of 120mm by 142mm stroke, and a R.A.C. rating of 53·5 h.p., the crankcase and cylinder block are a one-piece casting in fine-grained iron, the crankcase being divided on the centre line of the crankshaft. The cylinder heads are of cast iron, and each covers three cylinders, and carries injectors in water-cooled copper sheaths. Aluminium alloy pistons having an offset toroidal cavity in the crown are provided and have three pressure rings and one scraper ring above the gudgeon and a second scraper ring below. Alloy steel stampings form the connecting-rods which have phosphor-bronze bushed small ends and thick shell pattern copper-lead lined big-end bearings, while seven similar bearings carry the crankshaft.

Seven bronze bearings in the crankcase support the alloy cast iron camshaft, which has chill cast cams and is driven by a gear train at the front end of the engine. Bevel gears from the camshaft drive the fuel injection pump, on the side of which is mounted a vertical diaphragm pattern lift pump, while a centrifugal governor controls the idling and maximum speeds. A duplex oil pump is driven by helical gearing from the crankshaft

A Maintenance Grader

A LIGHT maintenance grader, with a working weight of 8000 lb and powered by a 42·5 b.h.p. motor, has been developed by Aveling Barford, Ltd., Invicta Works, Grantham, and is intended to be in production early next year. A prototype machine is illustrated herewith, it being shown with a bulldozer attachment in front of the normal blade in this illustration.

The grader blade is 9ft in length by 1ft 1½in in width, giving a cut 6in below ground and a lift of 7in above ground. Thrust is transmitted from the power axle to the blade through an "A" frame mounting made up of 1½in steel tube, the thrust fulcrum being a 1¾in diameter pin. The maximum blade thrust is 5000 lb, and the blade controls are hydraulically operated. There are two independent foot brakes on the final drive shafts, which allow power turns to be made in bad ground. The grader has a wheelbase of 8ft 10in and an overall length of 13ft. It has a four-cylinder Fordson "Major" engine giving 42·5 b.h.p. at 1800 r.p.m., and it has six forward speeds from 2½ to 15½ m.p.h. and two reverse speeds, with a semi-floating four-pinion differential drive. The hydraulic system consists of a Plessey gear pump operating at 350 lb per square inch. The bulldozer blade shown attached to the grader in the illustration is 6ft by 20in in size.

A Universal Folding Machine

PARTICULARS have been received of a motor-driven universal folding machine which is now being made in five models by F. J. Edwards, Ltd., 359, Euston Road, London, N.W.1. These machines are designed to perform a variety of forming operations on mild steel sheet and plate up to ¼in thick. Two models, with blade lengths of 98in and 74in, have a swing-out clamping beam, which enables trunk sections formed round the beam to be withdrawn. The other three models, with blade lengths of 50in, 74in and 98in respectively, have fixed beams. A photograph we reproduce below shows a 74in swinging beam machine.

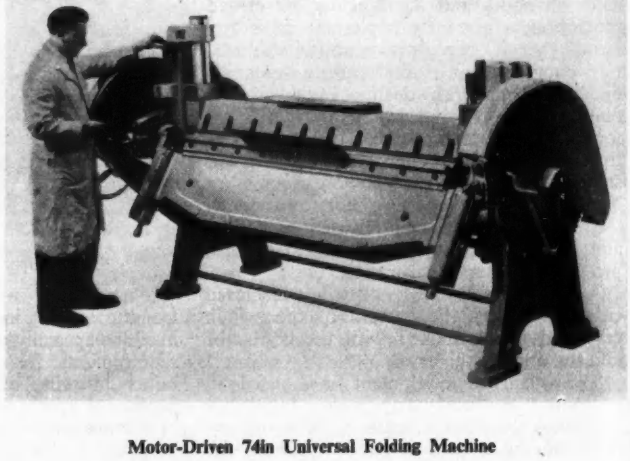
The machine has a bed and frame of close-grained cast iron, reinforced, to handle ¼in plate over the whole length of the bed. Its swing-out clamping beam is an alloy steel box section casting mounted on two heavy screws fitted with ball thrust races. A large knurled-head pin secures the beam in its working position, and when it is removed the beam can be swung out easily on the bearing at the left-hand end. The folding beam of cast iron box section has a wide L-section blade fitted along its working edge, and when narrow reverse leads are called for on light-gauge sheet this blade can readily be replaced by one with a narrow edge. At each end of the machine there is a graduated scale for folding beam alignment purposes, and an adjustable back gauge is fitted for repetitive work.

The folding beam is operated through a pinion and segment gearing by an electric motor at the rear. The folding operation is controlled through adjustable limit and reversing switches working in conjunction with a magnetic brake. With the switches set to give the required angle of bend it is only necessary to depress the starting button and the beam swings up, stops and then reverses to its rest position automatically. The makers state that one cycle for a 90 deg. bend is completed in six seconds.

The hand wheel operated clamping beam has a lift of 8in, which is sufficient to allow the use of right angle, goats' foot and special forming blades. Round mandrels can be fitted into slits in the folding beam trunnion arms and they incorporate means of vertical adjustment to the beam.

Each trunnion arm can be adjusted horizontally and vertically so that the folding axis can be kept in correct position and in alignment with the beams. When radius blades are used the folding axis is raised and aligned by vertical adjustment of the trunnion arms, and the folding beam is lowered to allow for the radius and thickness of metal being worked. The use of special radius blades, formers and mandrels increases the scope of the machine to cover most bends and combinations of bends likely to be required.

Maintenance Grader



Motor-Driven 74in Universal Folding Machine

Industrial and Labour Notes

European Steel Production

The United Nations Economic Commission for Europe shows in its *Quarterly Bulletin of Steel Statistics* that crude steel production in Belgium, France and Western Germany has tended to decline during the summer. In Western Germany, output in the first quarter of this year was at an annual rate of 17,144,000 metric tons, a figure which fell to 14,804,000 tons in the second quarter. In the rest of Europe, the Commission says, crude steel production has generally continued at record levels. Special mention is made of the British steel industry's record outputs.

In the eleven Western European countries from which the Commission has obtained information, together with those which are referred to as "small producers," crude steel production in the second quarter of this year was at an annual rate of 63,084,000 metric tons, compared with a rate of 63,950,000 tons in the corresponding quarter of last year. The *Bulletin* also points out that exports of steel from the principal Western European steel-exporting countries continue at a high level, although, taken together, they are much lower than in 1950 and 1951. On the other hand, imports of steel into the United Kingdom and Western Germany are still falling from the abnormally high levels which obtained during the latter part of 1952 and the early months of this year.

Coal Output

Last week's coal production amounted to 4,524,500 tons, which included 4,285,600 tons from the deep mines and 238,900 tons from opencast workings. In the first thirty-eight weeks of this year the saleable output of coal has amounted to 160,567,300 tons, compared with 163,170,100 tons in the corresponding period of last year. Coal consumption in the week ended September 19th, including export and bunker requirements, amounted to 4,063,000 tons and distributed stocks then totalled 16,959,000 tons, compared with 18,460,000 tons on September 20, 1952.

The number of wage earners on colliery books on September 19th was 713,700—or 6000 fewer than a year ago—but the number working at the face was 299,400, or 3000 more than on the comparable date of last year. Output per manshift at the face in the week ended September 19th was 3·118 tons.

The National Economy

The eighth annual general meeting of the Finance Corporation for Industry, Ltd., was held in London on Wednesday of last week, and in the course of his chairman's address, Viscount Bruce of Melbourne commented upon several aspects of the nation's economy. He said that despite the immense aid received, Britain had not yet succeeded in building up her gold and dollar reserves to an adequate level. At the end of August, they stood at 2469 million dollars, compared with 2476 million dollars at the end of 1945. Those reserves were far too low for safety, and the slightest adverse movement in trading conditions could bring about a fresh crisis. The increase in the reserves over the last year, though gratifying, was wholly inadequate for full recovery. In the light of that situation, Lord Bruce asserted, the economic position of Britain and the sterling area could only be described as extremely insecure and any other attitude was frankly unwarranted by the facts.

Lord Bruce went on to say that after the war it was clear that if Britain was to restore her financial and economic position and to protect the standard of living of her people, she had to increase her exports and reduce her imports to the minimum level compatible with her vital requirements of food and raw materials. Drastic action had been taken in respect to imports, and exports had been increased in a remarkable and gratifying manner. Last year, the volume of our exports was nearly 60 per cent above the 1938 level. But, Lord Bruce continued, in assessing that achievement, certain underlying factors had to be borne in mind. For some years after the termination of hostilities, the world's need to re-equip, reconstruct and restore the ravages of war created a strong sellers' market. By 1950, however, that need had been met to a considerable extent and the sellers' market was rapidly turning to a buyers' market. With the buyers' market again upon us, Lord Bruce observed, Germany and Japan had re-established their industrial production and their competition —which had been absent in the immediate post-war years—was progressively and rapidly becoming more formidable.

Having regard to those facts, Lord Bruce suggested, we were clearly faced with the gravest difficulties in maintaining, let alone expanding, our exports, and in those circumstances it was imperative that we should increase our production and reduce our costs. But, he added, the level of taxation to-day was such as to remove all incentives to increase productivity, and the overwhelming taxation burden carried by industry made it almost impossible to finance the improved methods required to reduce costs.

Essentials for Increased Output

Speaking at the annual meeting of the General Electric Company, Ltd., which was held in London on Thursday of last week, the chairman, Sir Harry Railing, called for the utmost effort to stop inflation by eliminating waste and increasing output. The need to eliminate waste, he said, was daily in front of employers ; it meant more economical designs, cheaper raw materials, greater standardisation and association agreements open to Government inspection and criticism.

The second aim—increased output—meant, Sir Harry continued, aggressive selling abroad, economical production, modernisation of tools and, last but not least, far-seeing research and ventures into new industries and markets. They all depended upon the funds which industry was permitted to retain, and upon whether industry was allowed to balance losses incurred on new ventures, against temporary so-called excessive "profits" in certain other circumscribed fields. It was not the size of the profit, Sir Harry claimed, that should be the criterion in any investigation, but whether the price asked for an article was a fair one in regard to world competition. Sir Harry went on to say that investment in British manufacturing industry was much less per person employed than in American industry. This suggested, he observed, that our competitive position was worsening rather than improving. With a labour force in manufacture twice the size of this country's, the U.S.A. spent five to six times as much as we did. The reason, Sir Harry declared, was not lack of enterprise on our part, but the lack of industrial capital, which was caused by taxation of industry on too high a scale and on a wrong basis. Great Britain spent 9 per cent of the gross national production on capital formation, the U.S.A. spent 11 per cent, and Germany spent 14 per cent.

Earnings and Hours in British Industry

The Ministry of Labour has published the results of an investigation into the average weekly earnings and hours of manual workers employed in manufacturing industries generally, and in a number of the principal non-manufacturing industries, in the United Kingdom. Investigations of this kind are made by the Ministry twice a year, and that which it has now reported upon was concerned with the last pay week in April. The necessary forms were sent to about 64,400 industrial establishments, and approximately 61,500 of them furnished returns suitable for tabulation. The number of wage earners (including part-time workers) covered by the returns was about 6,500,000, or rather more than two-thirds of the total at work at the time of the inquiry in the various industries concerned.

The report now made by the Ministry of Labour shows that in all the manufacturing industries considered, the average earnings in the last pay week of April were as follows :— Men, £9 11s. 11d.; youths and boys, £3 15s. 5d ; women, £5 1s., and girls, £3 2s. 11d. The percentage increases since October, 1938, the report states, are : men, 171 per cent ; youths and boys, 191 per cent ; women, 208 per cent, and girls, 239 per cent. In the group of manufacturing industries classified by the Ministry as "engineering, shipbuilding and electrical goods," the average weekly earnings in the last pay week of April were : men, £9 16s. 4d.; youths and boys, £3 13s. 8d.; women, £5 7s. 8d., and girls, £3 5s. 11d. The average hours worked in that group in the same week being men, 48·2 ; youths and boys, 44 ; women, 42·2, and girls, 42·5, the average hours in all the manufacturing industries considered together being 47·6, 44, 42 and 42·7 respectively. In a number of the industries included in the investigation there have been increases in the rates of wages since the last pay week in April. It is estimated that the effect of these increases has been to raise the general level of full-time weekly wage rates in the industries covered by the inquiry by about one-half of 1 per cent during the four months May to August inclusive.

Among the employments not covered by the Ministry of Labour's investigations were agriculture, coal mining, port transport, the distributive trades, British Railways, London Transport, and British Road Services. In the coal mining industry, information collected by the National Coal Board shows that for all classes of workpeople, including juveniles, but excluding women and girls, the average weekly cash earnings in the week ended May 2nd last were £11 14s. 1d., compared with £11 2s. 10d. in the week ended April 26, 1952. For adult male workers, of twenty-one and over, the weekly cash earnings in the week ended May 2nd last averaged £12 6s. 1d., compared with £11 13s. 3d. in the week ended April 26, 1952.

Industrial Production

The index number of industrial production (1948=100), which is prepared by the Treasury, has been estimated provisionally at 110 for all industries in July, compared with a revised figure of 118 for June. Figures for the corresponding months last year were 102 for July and 112 for June, but in making the comparison it should be borne in mind that the index was affected in June, 1952, by the Whitsun holiday and in June this year by the Coronation holidays. In both years, of course, annual holidays influence the July figure. Taking the manufacturing industries alone, the index number for July this year has been estimated at 112, compared with 102 in July, 1952. The Treasury says that, on the basis of information so far received, the index for all industries in August is expected to be 105 or 106.

Trade Disputes

According to statistics published in the *Ministry of Labour Gazette*, there were 132 stoppages of work through industrial disputes in progress in the United Kingdom during August. Directly and indirectly, 19,600 workpeople were involved in these stoppages which caused an aggregate loss of 56,000 working days. In August last year, there were 175 stoppages through disputes, involving 44,900 workpeople and causing a loss of 167,000 working days.

In its report, the Ministry of Labour has stated that in the first eight completed months of this year there were 1057 stoppages of work through disputes, which together involved about 174,400 workpeople and resulted in a loss of 734,000 working days. They included twenty-seven stoppages in the engineering industry, twenty-two in the vehicle building industry, thirty-four in the shipbuilding and ship-repairing industries, fifteen in the metal manufacturing industries, and 802 stoppages in the coal mining industry. In the comparable months of last year there were 1173 stoppages, involving 270,100 workpeople and resulting in an aggregate loss of 1,336,000 working days.

Notes and Memoranda

Rail and Road

A DIESEL SHUNTING LOCOMOTIVE.—The Hunslet Engine Company, Ltd., announces that it is to produce a new standard gauge 35 h.p. diesel-hydraulic shunting locomotive of 6½ tons weight, 2340 lb tractive effort, and capable of speeds up to 7 m.p.h. The locomotive is intended for small industrial yards where loads of up to 200 tons have to be shunted.

KILSBY TUNNEL.—Kilsby tunnel, between Welton and Rugby on the London Midland Region's main line to the north, is closed to all rail traffic until October 31st for work on a new drainage scheme which will enable unrestricted train speeds in the tunnel. The work involves the total removal of the permanent way and ballast down to the tunnel invert level, the construction of a new culvert and cross drain system, partial channel drainage along the tunnel walls, the erection of down pipes, the construction of two new reinforced concrete rafts under the main shafts, and the formation renewal of the northern approach, total reballasting and replacement of permanent way. The London Midland Region of British Railways says that Kilsby tunnel, which is 1 mile 666 yards in length, presented many difficulties during its construction in 1838. Robert Stephenson, who was engineer of the works, had then to design special equipment to deal with the enormous quantity of water found. While the tunnel is closed passenger trains are running via Northampton or are being diverted to St. Pancras and special arrangements are being made to minimise delays to travellers.

THE ROMFORD BUS GARAGE.—Romford (North Street) garage, the latest to be completed under London Transport's post-war programme, has recently been brought into use. It occupies a 2-acre site bounded by North Street, Seymer Road and Park Drive, and provides accommodation for the parking and day-to-day maintenance of 115 buses of the Central Road Services fleet, whilst incorporating an operating and welfare block containing offices, canteen and recreation room. No facilities for heavy maintenance are provided ; from an engineering point of view the garage will be subsidiary to Hornchurch, where the appropriate installation is now being added. The building is of steel-frame construction with brick facings. The greater part is taken up by the parking area, which is some 285ft by 120ft, under a single-span steel truss and asbestos-cement roof. The roofing over the remaining accommodation is of flat precast concrete units covered with vermiculite insulation and asphalt. The interior working of the garage follows London Transport's post-war pattern ; a bus coming off the road passes to the first position in a servicing line for vacuum cleaning and refuelling, then to the second position for exterior cleaning by automatic washing machine, and on to its allotted parking place. A roof washing machine of London Transport's own design is to be installed. At the far end of the parking area are five pits. All pits have fluorescent lighting, floor-level heating, and compressed air points. Exhaust fumes are drawn off by extract fan to the atmosphere.

Air and Water

LAUNCH OF LIGHT VESSEL.—Last week the light vessel "Kentish Knock" was launched from the Noss works of Philip and Son, Ltd. It is the twenty-second light vessel built by the company for the Corporation of Trinity House.

PROPELLER BROCHURE.—An illustrated brochure on the manufacture of propellers has been published recently by John I. Thornycroft and Co., Ltd., which outlines the current methods of manufacture and gives the capacity of the plant.

FLOATING FUELLING STATION.—A self-propelled floating fuelling station is now operating at Lisbon to supply the port's fishing fleet. The vessel, named "Shell-Nautilus," has a length of 65ft by 16ft beam, is propelled at 8 knots by a four-cylinder diesel engine of 120 b.h.p. and carries 50 tons of gas oil.

DANISH TRAINING SHIP.—Last week the training vessel "Danmark," which is owned by the Danish Government, paid a visit to London before sailing for South America. This three-masted full-rigged sailing ship of 784 gross tons was built in 1933 by Nakskor Skibsvaert Akt. and has for its sole purpose the training in sail which is necessary for cadets to obtain before proceeding to a navigation school. There is accommodation for 120 cadets and a crew numbering seventeen is carried. Besides having a sail area of 17,600 square feet, the ship has a small engine-room, in which is a six-cylinder Frich, four-stroke, single-acting diesel engine developing 250 b.h.p. at 300 r.p.m. to provide auxiliary propulsive power, two diesel-driven generators and an oil-fired vertical boiler.

R.A.F. UNIVERSITY COURSES.—The first of a regular flow of Royal Air Force officers who will be qualified to deal with the more complex weapons of future air defence recently completed the first stage of an intensive training programme at the R.A.F. Technical College, Henlow, Bedfordshire. They include the first twenty technical university cadets to be trained under a scheme recently introduced by the Royal Air Force, and are now being sent to universities for three years to qualify for Honours Degrees in Engineering. They will then return to the Technical College for a short course of instruction before filling appointments in the R.A.F. Technical Branch. Other technical cadets, following a different curriculum, will remain at the Technical College to complete a further two years' training before receiving permanent commissions in the Technical Branch.

Miscellanea

THE ELECTRICAL ASSOCIATION FOR WOMEN.—The twenty-ninth annual conference of the Electrical Association for Women will be held in Torquay from Monday, May 17, to Thursday, May 20, 1954.

STRESS-FREE CASTINGS.—The production of high-performance castings using anodised aluminium dies is described in a new publication, "'Niforge' Stress-Free Castings by the Parlanti Process," issued by Carron-Parlanti, Ltd., Carron, Falkirk, Stirlingshire.

LECTURES ON NON-DESTRUCTIVE TESTING.—A course of nine lectures on "Methods of Non-Destructive Testing" is to be given at the South-East Essex Technical College, Longbridge Road, Dagenham, on Tuesday evenings, at 7 p.m., beginning on October 20th. The fee for the course is two guineas.

OIL SEARCH IN BORNEO.—The Shell Petroleum Company, Ltd., has begun a new phase in the search for oil in North Borneo. A concession area of 1000 square miles, consisting of the Dent Peninsular on the east coast and the Klias peninsular in the west, is now under development. A gravity survey is being carried out in the Dent peninsular, while in the Klias peninsular it is planned to commence deep exploration drilling next year.

THE WOMEN'S ENGINEERING SOCIETY.—Last week-end the Women's Engineering Society held its thirty-first annual conference in London. The annual general meeting took place on Saturday, the programme for that day including also a visit to the engineering laboratories at King's College. The annual dinner was held on Saturday evening with the president, Dr. E. M. Collin, in the chair. On Sunday afternoon, the president delivered her address entitled "The Development of Technical Education."

BRITISH INSTITUTE OF MANAGEMENT.—The annual conference of the British Institute of Management is to be held at Harrogate from Wednesday to Saturday, November 11th to 14th. Lord Reith will address the opening session on Wednesday evening, November 11th, and at the final plenary session on Saturday morning, November 14th, Sir Ewart Smith is to speak on "Productivity and Management." Full details of the conference may be obtained from the British Institute of Management, 8, Hill Street, London, W.1.

SUGAR BEET HARVESTING MACHINERY.—The demonstration of sugar beet harvesting machinery, which is arranged annually by the British Sugar Corporation, is to be held this year at Cherrington Manor, Newport, Salop, on Thursday and Friday, October 22nd and 23rd. Twenty-five complete beet harvesters are expected to be working throughout the demonstration, which will include also a display of equipment designed for the saving of beet tops. Visitors to the demonstration will also be able to see a selection of equipment used for the preparation of silage from beet tops. Full details of the demonstration may be obtained from the British Sugar Corporation, 134, Piccadilly, London, W.1.

CAREERS MEETING.—The London County Council states that the Hampstead and St. Pancras Youth Employment Committee will hold a "careers meeting" on Tuesday next, October 6th, at 7.30 p.m., at the Richard Cobden School, Camden Street, N.W.1, for young people fifteen to eighteen years of age interested in employment in the engineering industry. The school will open at 7 p.m. so that visitors can first see an exhibition which is being arranged. Both experienced workers and apprentices will be present to give the facts and answer questions on employment in mechanical and electrical engineering, tool-making, motor vehicle repair, instrument making, and other engineering trades.

MR. CHARLES WATTS.—We have learned with regret of the death of Mr. Charles Watts, which occurred at his home at 32, Gourock Road, Eltham, S.E.9, on September 2nd. Mr. Watts, who was eighty-four, had spent many years of his long engineering career in the motor-car industry. He began with the Auto Machinery Company, Ltd., Coventry, and was subsequently the first draughtsman to be employed by the Hillman Company, at Pinley, joining the firm in 1907 when its total personnel was less than twenty. In more recent years, Mr. Watts had been in business, on his own account, engaged in the preparation of machine designs for engineers and inventors. He contributed several articles to our columns, among them being "Formed Cutters and Hobs," which appeared in our issue of May 15, 1936, and "The Steel Ball : Early Methods of Manufacture," which was published on December 28, 1934.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The next examinations of the Institution of Heating and Ventilating Engineers will be held as follows :—Section A, April 5 to 9, 1954, and Section B, May 20, 21 and 22, 1954. Candidates who have already submitted proposal forms for membership and have been accepted as examination candidates must submit an examination application form, which is obtainable from the secretary, before February 28, 1954 (January 31st for overseas candidates). Candidates who have not previously made application are required to submit proposal forms for membership, and these must be considered by the committee before permission to enter the examination can be granted. Such proposal forms must be received by the secretary not later than December 31, 1953, and no guarantee can be given that proposal forms received after that date can be dealt with in time to enter approved candidates for the 1954 examinations. Students and graduates of the Institution are not required to submit a transfer application form, as they are permitted to enter for the appropriate section of the Associate membership Examination (A or B) on completion of an examination application form before February 28, 1954 (January 31, 1954, for overseas candidates).

A LARGE MINE FAN WHEEL.—A "Sirocco" backward aerofoil bladed mine fan wheel constructed by Davidson and Co., Ltd., of Belfast, has been delivered by road to the Snowdown Colliery in Kent. This wheel weighs some 7 tons and is designed to handle 500,000 cubic feet of air per minute with a water gauge of 12in when running at 548 r.p.m.

THE ROYAL AGRICULTURAL SOCIETY.—The Royal Agricultural Society of England has produced a booklet entitled *Practice with Science*, which contains a brief and up-to-date outline of the Society's activities since its inception in May, 1838. Naturally, much of the information given in the booklet is to be found in the *History of the R.A.S.E.*, which was prepared by Sir James Scott Watson in 1938, as the Society's centenary volume. But all who may desire to know more about the Society's work will find this new publication both helpful and interesting. The Society's main objects have not altered since its foundation, one of them being "to encourage men of science in their attention to the improvement of agricultural implements." One chapter of the booklet with special interest to engineers, therefore, is that which surveys the Society's implement and machinery trials, and which records other efforts which it continues to make in the interests of mechanised agriculture. The chapter on the Society's show, which has been held annually, with few unavoidable interruptions, since 1839 is another of particular interest to engineers.

COMBINED REGIONAL OFFICES.—The regional offices of the Board of Trade and the Ministry of Supply for the London and South-Eastern, Midland, and Southern Regions have now been combined as from September 14th. The names of the Controllers and the addresses to which communications should be addressed are as follows :—London and South-Eastern, C. S. Toseland, Cromwell House, Dean Stanley Street, London, S.W.1, although until further notice communications on Ministry of Supply matters for this Region should continue to be addressed to the Controller, Mitre House, 177, Regent Street London, W.1 ; Midland Region, B. W. T. Kay, C.M.L. Building, Great Charles Street, Birmingham, 3 ; Southern Region, F. A. Swann, Marlborough House, Parkside Road, Reading, Berks. The offices of the Board of Trade and the Ministry of Supply in other Regions will continue to operate independently until specific notice of combination is given. In the meantime, the present Controllers remain fully responsible for the work of their respective offices. It will be recalled that the intention to merge the regional offices was announced by the President of the Board of Trade on July 30th.

Personal and Business

MR. W. HARPER HILL has joined the board of C. and M. Engineering Company, Ltd., Thames Road, Barking, Essex.

MR. D. S. THOMSON, Winnipeg, has been appointed vice-president, operation and maintenance, of the Canadian Pacific Railway.

MR. C. BERESFORD CLARK has been appointed sales manager, lubricants, of the Regent Oil Company, Ltd., 117, Park Street, London, W.1.

C. A. PARSONS AND CO., Ltd., states that Mr. I. Clunas has been appointed manager of the Bristol office in succession to Mr. J. Packard, who is now manager of the London office.

MR. J. A. TAYLOR, A.M.I.C.E., has retired from the staff of Pritchett and Gold and E.P.S. Company, Ltd., Dagenham Dock, Essex. He has been in the firm's service since 1919.

WILSON AND LONGBOTTOM, Ltd., Nelson Foundry, Barnsley, has formed a new company, to be known as Wilson and Longbottom (Engineers), Ltd., to deal with the manufacturing side of its business.

AUTO DIESELS, Ltd., Uxbridge, states that Air Commodore James Warburton has been appointed a director. He will be concerned principally with the company's aircraft equipment division.

MAJOR-GENERAL W. A. LORD, C.B.E., M.I.Mech.E., M.I.E.E., is to succeed Major-General S. W. Joslin, C.B., M.I.Mech.E., M.I.E.E., as Director of Mechanical Engineering at the War Office on January 1, 1954.

FINNEY PRESSES, Ltd., announces that it has opened an office at 5, New Bridge Street, London, E.C.4 (telephone, City 4815), and that Mr. E. P. Bridson has been appointed London and Home Counties representative.

IGRANIC ELECTRIC COMPANY, Ltd., Bedford, states that Mr. Dermot W. Kent has resigned from the board in order to take up the position of commercial director with its associated company, Sentinel (Shrewsbury), Ltd.

G.P.U., Ltd., and its subsidiary, the Electroplant Company, Ltd., have moved their London office to 44, Bryanston Street, W.1. The companies' works and stores have been transferred to their associated firm, H. Fisher (Oldham), Ltd., Oldham, Lancs.

THE MINISTRY OF CIVIL AVIATION states that Mr. G. McD. Wilson has been appointed to the post of alternate delegate to the United Kingdom representative on the Council of the International Civil Aviation Organisation, Montreal, in succession to Mr. I. V. Pugh.

THE MINISTER OF FUEL AND POWER has appointed Mr. W. H. Sales to be a full-time member of the National Coal Board to fill the vacancy caused by the retirement of Mr. Ebby Edwards. Mr. Sales is at present deputy chairman of the North-Western Division of the Board. His new appointment is for a period of five years.

British Patent Specifications

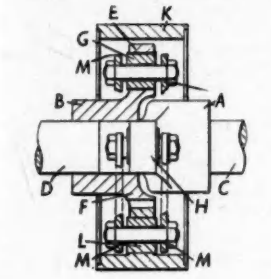
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

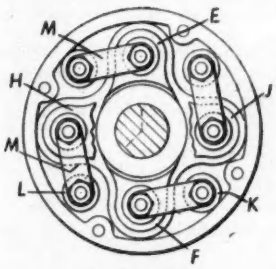
Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

POWER TRANSMISSION

696,378. November 2, 1950.—UNIVERSAL COUPLINGS, Metalastik, Ltd., Evington Valley Road, Leicester. (*Inventor: Charles Wallace Chapman.*)

The coupling shown in the drawing comprises two identical hub portions *A* and *B* for connection with shafts *C* and *D*. The hub portion *B* has diametrically extending arms *E* and *F* projecting from it for receiving a pair of resilient bushes *G*, while the hub *A* has arms *H* and *J* also fitted with resilient bushes. Each bush is bonded between inner and outer sleeves, the outer sleeve being a jamming fit in the arms. The two extremities of the arms are offset axially, and in assembling the coupling the two hub portions are so



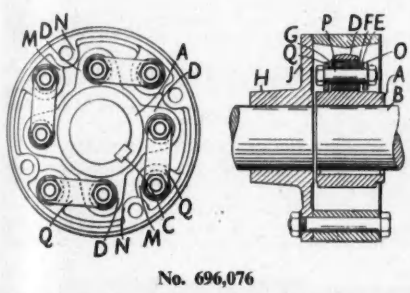


No. 696,378

disposed that their arms are at right angles to one another and the centres of the bushes lie substantially in one plane. The two hub portions are encircled by a connecting element *K*, from which four bosses project inwards being disposed between the extremities of the arms on the hub members. Each of the four projections has a resilient bush *L* bonded between sleeves, the outer sleeves being a jamb fit in the projections. The inner sleeve of each of these bushes is connected to the inner sleeve of one of the bushes on one of the hubs by two links *M*.—*August* 26, 1953.

696,076. November 2, 1950.—UNIVERSAL COUPLINGS, Compression Ignition, Ltd., The Green, Twickenham, Middlesex; and Charles Wallace Chapman, Briar Cottage, Burstow, near Horley, Surrey.

As shown in the drawing, one part of the coupling comprises a hub portion *A* keyed to the end of one shaft. The hub has four lugs or bosses *D* spaced around its circumference and each of which is bored



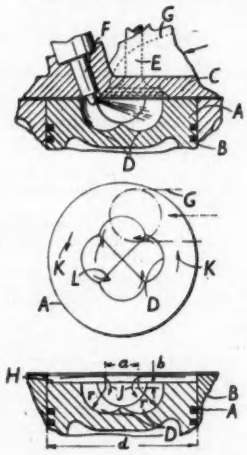
No. 696,076

to receive a resilient bush comprising inner and outer sleeves *E* and *F* between which is bonded a rubber cushion *G*. The other part of the coupling comprises a hub *H* keyed to its shaft and provided with a flange *J*. Bolted to this flange is a rim, which is provided with four bosses projecting into the spaces between the lugs *D* on the first hub. These bosses are also drilled to receive resilient bushes. Located close to each of the bosses *M* are other drilled bosses *N*, through which the bolts extend. These bolts also pass through holes in an annular cover plate *O*. A bolt *P* extends through the inner sleeve *E* of each resilient bush and through a hole in a link *Q* flanking the bush. The head of the bolt at one end abuts one link, while the threaded extremity of the pin receives a clamping nut which abuts against the other link, whereby the inner sleeve *E*, which is longer than the outer sleeve *F*, is firmly secured between the links, thus the pivotal movement is resiliently resisted by the rubber bush which is bonded both to the inner and outer sleeves.—*August* 26, 1953.

INTERNAL COMBUSTION ENGINES

696,371. May 12, 1950.—RECIPROCATING FUEL INJECTION ENGINES, R. A. Lister and Co., Ltd., Victoria Ironworks, Long Street, Dursley, Gloucestershire. (*Inventor: Alberto Jorge Morris.*)

The object of the invention is to provide improved combustion characteristics. In the drawings the piston *A* in the cylinder *B* is shown at the top dead centre position with a minimum of clearance from the cylinder head *C*. Four part-spherical depressions *D* forming the combustion cavity are shown, the centres of all the depressions lying on a circle. The inlet valve is indicated at *E* and the exhaust valve is omitted. The injection nozzle *F* may be placed at the centre of the combustion cavity or towards one side, as shown. It may have one or more spraying holes, but the number of spraying holes should not exceed the number of part-spherical depressions. Preferably the dimensions of the depressions are related to the diameter *d* of the piston as follows :—*a*=0·01 to



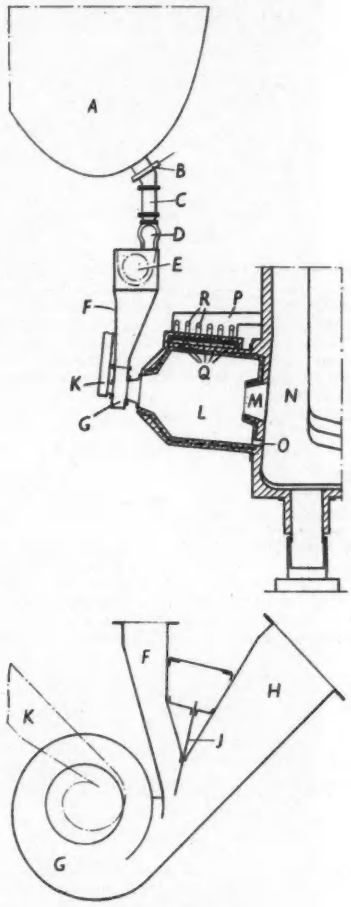
No. 696,371

0·33*d*; *b*=0 to 0·1*d*; and *r*=0·1 to 0·25*d*, where *a* is the diameter of the pitch circle on which lie the spherical centres of the depressions; *b* is the distance between such a spherical centre and the adjacent end face of the piston; and *r* is the spherical radius of the depressions. For causing the air swirl in the cylinder the induction passage *G* is arranged substantially tangential to the generally annular space *H* round the combustion cavity. It will be understood that the "squished" air has a toroidal motion in the combustion cavity, arrows *J* in the lower view, in addition to its swirl motion, arrows *K* in the centre view, and that the swirl component of the motion causes the air to depart from the lateral boundary wall of the combustion cavity where two of the depressions merge with one another, arrows *L*. It is this combined motion imparted to the air which ensures the thorough mixing of the air with the fuel.—*August* 26, 1953.

FURNACES

696,295. September 29, 1950.—CYCLONE FURNACES, Babcock and Wilcox, Ltd., Babcock House, Farringdon Street, London, E.C.4.

The invention relates to cyclone furnaces, which operate with whirling of combustion air and granular fuel around the combustion chamber with combustion at a temperature above the melting point of the ash in the fuel and with evacuation of slag in molten form. The drawing shows a coal bunker *A* connected through a slide valve *B* for shutting off the flow of coal, a duct *C* and a feeder *D* to a hammer mill *E* for crushing the coal. The granulated coal outlet from the mill is in communication with a duct *F* forming part of a burner *G*. The lower part of the duct is formed as a nozzle-shaped fuel supply means for the burner and the duct *F* and a duct *H*, the end of which is formed as a nozzle-shaped air supply means for the burner, converge to a confluence, the fuel supply and the air supply being arranged after the manner of an ejector. The nozzle-shaped end of the duct *H* is tangential to the scroll-shaped peripheral wall of a whirl chamber forming part of the burner *G*. A plate *J* forming a division wall between the fuel supply and air supply ducts can be moved to regulate the suction effect. The whirl chamber of the burner has an auxiliary chamber of relatively small diameter fitted at its outer end with an inspection shutter. Opening tangentially into the auxiliary whirl chamber is an air duct *K*. The air supplied through the duct serves to create a partial vacuum, which enables the inspection shutter to be opened without the flame bursting out. The substantially cylindrical, refractory walled combustion chamber *L* is formed with a co-axial gas outlet throat *M* leading to a boiler radiation space *N* towards which the combustion chamber is inclined downwards at a small angle towards a slag



No. 696,295

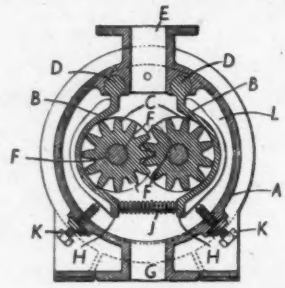
opening *O*. A secondary air duct *P* connects with nozzles *Q* communicating tangentially with the combustion chamber. The nozzles *Q* and additional fuel nozzles *R* are also arranged after the manner of an ejector. During operation, coal supplied from the bunker and crushed by the mill *E* is supplied to the burner duct, whilst primary air at substantial pressure is supplied through the duct *H*. Owing to the ejector action exerted by the air flowing in the duct *H*, a suction is created in the duct *F* or pressure applied to the interior of the duct is very much less than the pressure of the air supplied to the duct *H*. The scroll-shaped surface of the burner *G* causes the primary air and fuel mixture to rotate, with the result that it enters the combustion chamber with a strong whirl and revolves helically round its peripheral wall while combustion takes place. Secondly, air is supplied through the nozzles *Q*. The hot gases pass through the outlet throat *M* to the radiation space *N* and the molten slag runs down the walls of the combustion chamber and out of the opening *O*. —*August* 26, 1953.

PUMPS

696,320. May 30, 1951.—GEAR PUMPS, Barclay, Kellett and Co., Ltd., Richter Works, Joseph Street, Bradford; and Cecil Maddison Barclay, of the company's address.

The object of the invention is to provide a construction of pump in which wear is taken up as it occurs. Within the casing *A* of the pump there is hinged a pair of curved shoes *B*, which partly encircle

and engage or are in close proximity to the pinions *C*. The shoes are hinged and each hinge pin *D* is formed integrally with one of the shoes so that they are hinged to the casing at the delivery side *E* of the pinions, preferably in planes outwardly offset from, but parallel to, the centre lines of the shafts. The ends of the shoes *B* at the suction side *G* of the pinions are formed with flanges *H* and pegs which support a helical compression spring *J* which acts normally to force the shoes apart and clear of the pinions. Projecting through the casing of the pump on each side of the suction inlet *G* of the casing is a set screw *K*, which bears against its adjacent shoe *H* so that by adjusting the set screws the respective shoes can be brought close to the pinions and wear on the overall diameter of the pinions can be taken up as it takes



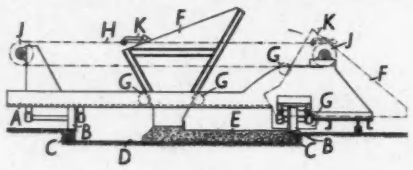
No. 696,320

place. The faces of the pinions bear against side plates *L* secured between the pinions and the detachable end plates of the pump body. When wear takes place on the faces of the pinions one or other of the side plates *L* can be reversed. In order to reduce wear on the meshing surfaces of the teeth of the pinions instead of one pinion driving the other, the shafts of the pinions may be connected by a pair of synchronised gears.—*August* 26, 1953.

CIVIL ENGINEERING

696,272. January 10, 1952.—Concrete Spreading Apparatus, Aktiebolaget Vibro-Betong, 29, Luntmakaregatan, Stockholm, Sweden. (*Inventor : Carl Gunnar Lindgren.*)

As the drawing shows, the apparatus consists of a truck *A* which can be moved on wheels *B* along suitable tracks *C* laid on each side of the surface *D* on which the concrete *E* is to be applied. The framework supports a funnel-shaped hopper *F* provided with running wheels *G* which permit the transverse



No. 696,272

movement of the hopper in the framework. Movement is imparted to the hopper *F* by a motor through an endless chain *H* which runs over guide rollers *J* and a link *K* one end of which is connected to the chain whilst the other end is connected to the hopper. By the invention the hopper may be tipped from an upright emptying position, shown in full lines, to a sloping filling position, shown in dotted lines. The hopper may be tilted around a shaft which is at right angles to the direction of its movement in the spreader, and tipping takes place at one end of the framework. Tipping of the hopper is preferably effected with the help of curved guides as soon as it has been moved forward to the end position in the framework.—*August* 26, 1953.

Launches and Trial Trips

Anita, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for Erling H. Samuelsen Oslo ; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, deadweight 18,100 tons ; trial speed 15 knots ; two 75kW steam-driven generators, one 75kW diesel-driven generator ; Hawthorn-Doxford opposed-piston, two-stroke oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6600 b.h.p. at 115 r.p.m., two Scotch cylindrical boilers. Launch, September 9th.

Port Montreal, cargo liner ; built by Harland and Wolff, Ltd., for the Port Line ; length between perpendiculars 440ft, breadth moulded 64ft, depth moulded to shelter deck 39ft 5in, gross tonnage 6400 tons ; three continuous decks, five cargo holds, fourteen 15-ton derricks, one 70-ton derrick, electrical deck machinery, three 300kW diesel-driven generators ; Harland-B. and W. single-acting, two-stroke, opposed-piston oil engine, burning heavy fuel oil, seven cylinders 750mm diameter by 2000mm combined stroke, 112 r.p.m. Launch, September 22nd.

Hazelwood, cargo liner ; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Moor Line, Ltd. ; length between perpendiculars 423ft, breadth moulded 58ft, depth moulded to upper deck 29ft, draught 25ft 8¾in, deadweight 9540 tons, service speed 13 knots ; five cargo holds, steam deck machinery, derricks include one to lift 30 tons, two 40kW steam-driven generators ; Hawthorn-Doxford opposed-piston oil engine, four cylinders, 600mm diameter by 2320mm combined stroke, 3300 b.h.p. at 108 r.p.m. Launch, September 22nd.

St. John, cargo liner ; built by Joseph L. Thompson and Sons, Ltd., for the South American Saint Line, Ltd. ; length between perpendiculars 440ft, breadth moulded 59ft 4in, depth moulded 39ft 8in, mean draught 26ft 9in, deadweight 9600 tons ; Doxford opposed-piston oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5300 b.h.p. at 114 r.p.m., service speed 14 knots. Launch, September 22nd.

Neptune, cargo liner ; built by Swan, Hunter and Wigham Richardson, Ltd., for the Compania Naviera Hesperia S.A., Panama ; length between perpendiculars 435ft, breadth moulded 60ft, depth moulded to shelter deck 39ft, gross tonnage 5750 tons ; five cargo holds, steam deck machinery, one 20-ton derrick, one 50-ton derrick ; two 35kW steam-driven generators, one 31kW diesel-driven generator ; Swan, Hunter-Doxford opposed-piston oil engine four cylinders, 670mm diameter by 2320mm combined stroke, 4400 b.h.p. at 115 r.p.m.

Nuddea, cargo liner ; built by Barclay Curle and Co., Ltd., for the British India Steam Navigation Company, Ltd. ; length 514ft, breadth 67ft, depth to shelter deck 42ft, gross tonnage 9800 tons, service speed 16½ knots, six cargo holds, two heavy derricks, one of 25 tons and one of 50 tons capacity ; electrical deck machinery, four 300kW diesel-driven generators ; one set of Parsons triple-expansion steam turbines, driving the propeller shaft at 116 r.p.m. through double reduction gearing, steam supplied at 450 lb per square inch and 750 deg. Fah. by two water wall water-tube boilers. Launch, September 23rd.

Catalogues

The Record Electrical Company, Ltd., Broadheath, Altrincham, Cheshire.—Brochure describing graphic recording instruments.

B.K.L. Alloys, Ltd., Birmingham Factory Centre, King's Norton, Birmingham, 30.—Catalogue describing Tubend welding fittings.

Holman Bros., Ltd., Camborne, Cornwall.—Leaflet VC/1111/53, "The Vibratory Classifier and Details of Portable Air Compressors."

Compoflex Company, Ltd., 26, Grosvenor Gardens, London, S.W.1.—Brochure on flexibles, entitled "Compoflex Flexible Tubing and Hoses."

Cambridge Instrument Company, Ltd., 13, Grosvenor Place, London, S.W.1.—Leaflet describing the redesigned Cambridge universal measuring machine.

South Bend Lathe Works, 425E, Madison Street, South Bend 22, Indiana, U.S.A.—Catalogue giving details of South Bend 9in precision lathes.

Fisher Governor Company, Ltd., Century Works, Lewisham, London, S.E.13.—Abridged general catalogue No. FG2-GB, describing automatic controls.

Newall Group Sales, Ltd., Peterborough.—Copies of the Newall Group sales general leaflets, printed in English, German, French, Italian and Spanish.

George Cohen Sons and Co., Ltd., Cunard Works, Chase Road, London, N.W.10.—First comprehensive post-war catalogue of entire stock of new and second-hand plant and machinery. To be published three or four times a year.

The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2.—Leaflet containing particulars of platform and silo grain dryers in complete units consisting of Woods "Aerofoil" or propeller fans and G.E.C. duct air heaters.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Oct. 20th.—54, Station Road, New Barnet, Herts, Presidential Address, "Education and Training in the Electrical Industry," C. T. Melling.

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Oct. 8th.—Scottish Section : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Microwave Test Bench and its Components—a Practical Introduction to Waveguide Work," J. Bilbrough, 7 p.m.

Wed., Oct. 14th.—N.E. Section : Institution of Mining and Mechanical Engineers, Newcastle upon Tyne, "The Impact of Communication Theory on Television," D. A. Bell, 6 p.m.

ELECTRIC RAILWAY SOCIETY

Sat., Oct. 3rd.—Fred Tallant Hall, 153, Drummond Street, London, N.W.1, "The Electric Railways of Merseyside," R. K. Kirkland, 3 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 6th.—Edinburgh Branch : 25, Charlotte Square, Edinburgh, Members' Papers, 7 p.m.——London Branch : Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Patterns, Castings and Foundry Work : An Introduction," Barnet Levy, 7 p.m.

Wed., Oct. 7th.—Southampton Branch : Polygon Hotel, Southampton, "Oxygen in Industry," E. Ryalls, 7 p.m.

Thurs., Oct. 8th.—N.E. Branch : Roadway House, Oxford Street, Newcastle upon Tyne, "The Use of Paint in Factories," P. J. Gay, 7 p.m.

Mon., Oct. 12th.—Dundee Branch : Mathers Hotel, Dundee, "Factory Instrumentation," 7.30 p.m.

Tues., Oct. 13th.—Manchester Branch : Engineers' Club, Albert Square, Manchester, "The Plant Maintenance Team's Visit to the U.S.A.," Colin Troup, 7.15 p.m.

Wed., Oct. 14th.—E. Midlands Branch : E. Midlands Gas Board Showrooms, Parliament Street, Nottingham, "The Works Engineer and the Factories Act," 7 p.m.

Thurs., Oct. 15th.—Blackburn Branch : Grosvenor Hotel, Lord Street, Blackburn, "Gunite in Industrial Building Maintenance," G. N. Ternan, 7.30 p.m.

INSTITUTE OF FUEL

Wed., Oct. 7th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, Melchett Lecture for 1953, "The Domestic Appliance Industry and Fuel Usage," Harold Hartley, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Oct. 5th.—85, Minories, London, E.C.3, "Ship-building," G. Ridley Watson, 6.30 p.m.

Tues., Oct. 13th.—85, Minories, London, E.C.3, "Operation of a Gas Turbine under Sea Conditions," J. Lamb, 5.30 p.m.

INSTITUTE OF PETROLEUM

Wed., Oct. 14th.—26, Portland Place, London, W.1, Redwood Lecture, "The Friction of Solids," F. P. Bowden, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Wed., Oct. 7th.—London Branch : Royal Society of Arts, John Adam Street, London, W.C.2, Annual General Meeting, followed by "Transport in South Africa," T. F. Turton, 6.30 p.m.

Fri., Oct. 9th.—S. Wales Group : B.O.C. Works, Birchgrovcon, Caerphilly Road, Cardiff, "Welding Methods," 7 p.m.

INSTITUTE OF WELDING

Wed., Oct. 7th.—Slough Section : Community Centre, Farnham Road, Slough, Bucks, "Organisation for Production of Welded Ships," D. M. Kerr, 7.30 p.m.

Thurs., Oct. 8th.—N. London Branch : Manson House, Portland Place, London, W.1, "Automatic Welding," R. L. Swan, 7.30 p.m.——S. London Branch : 2, Savoy Hill, London, W.C.2, Chairman's Address followed by Discussion, "Weld Preparations—What is the Aim ?" E. Fuchs, F. C. Cocks and D. M. Kerr, 6.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Sat., Oct. 10th.—Reynolds Hall, College of Technology, Manchester, George E. Davis Memorial Lecture, Norman Swindin, 3 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 5th.—S. Midland Centre : Grand Hotel, Birmingham, Annual General Meeting, Chairman's Address and Conversazione, 6 p.m.

Tues., Oct. 6th.—N. Midland Centre : British Electricity Authority, 1, Whitehall Road, Leeds, 1, Chairman's Address, G. Caton, 6.30 p.m.

Wed., Oct. 7th.—Scottish Centre : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Inauguration and Chairman's Address, F. M. Bruce, 7 p.m.

Thurs., Oct. 8th.—Ordinary Meeting : Savoy Place, London, W.C.2, Inaugural Address as President, H. Bishop, 5.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 6th.—39, Elmbank Crescent, Glasgow, Presidential Address, Sir William Wallace, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Oct. 6th.—Automobile Division : Storey's Gate, St. James's Park, London, S.W.1, Annual General Meeting, Address by the Chairman of the Division, 5.30 p.m.

Wed., Oct. 7th.—Southern Branch—Sussex Area : Downbarton, Grand Avenue, Hove, 3, Committee Meeting, 7 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., Oct. 6th.—Ordinary Meeting : Institution of Electrical Engineers, Savoy Place, London, W.C.2, Chairman's Address, "Recent Developments in Subscribers' Apparatus and Services," F. C. Carter, 5 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Oct. 6th.—N. Ireland Branch : College of Technology, Belfast, Chairman's Address, J. C. Malcomson, 6 p.m.

Wed., Oct. 7th.—N. Counties Branch : Neville Hall, Newcastle, Chairman's Address, "History of Reinforced Concrete," T. Bryce, 6.30 p.m.——Lancashire and Cheshire Branch : Reynolds Hall, College of Technology, Manchester, "Drawing-Office Procedure for Welded Designs," S. M. Reisser, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 2nd.—Townsend House, Greycoat Place, London, S.W.1, Film Evening, 7 p.m.

Wed., Oct. 7th.—Midland Section : James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting and Film Evening, 7 p.m.

Fri., Oct. 9th.—Townsend House, Greycoat Place, London, S.W.1, "Industrial and Marine Gas Turbines," A. W. Pope, 7 p.m.

LIVERPOOL JOINT CHEMISTRY COMMITTEE

To-day, Oct. 2nd.—Arcadian Restaurant, Morecambe, "Retail Marketing of Motor Spirit and Lubricants in the United Kingdom," J. R. Higdon, 8.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Oct. 2nd.—Engineers' Club, Albert Square, Manchester 2, Inaugural Address of President, H. Wright Baker, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Wed., Oct. 7th.—11, Upper Belgrave Street, London, S.W.1, "Aggregate Grading and Concrete Mix Design," D. A. Stewart 6 p.m.

SOCIETY OF ENGINEERS

Mon., Oct. 5th.—Geological Society, Burlington House, London, W.1, "Surface Finish and its Measurement by Electronic Methods," S. F. Smith, 5.30 p.m.

TELEVISION SOCIETY

Fri., Oct. 9th.—Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2, "Recording Television Programmes," C. B. B. Wood, 7 p.m.